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NOTES

REVIEWS

LIST OF ILLUSTRATIONS

Besides, there are nine charts accompanying Mr. Joshi's paper and two accompanying Mr. Vittal Rao's paper.

The following Original Articles will appear in our next issue (September 1920).

Original Articles

SOME COMMON INDIAN BIRDS.

No. 4. THE CATTLE EGRET (*BUBULCUS COROMANDUS*).

BY

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Imperial Entomologist;

AND

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Most of the birds dealt with in these articles are of general occurrence and as likely to be found in Calcutta, or any other large town, as in the surrounding country-side, but the subject of our present paper seems to have little use for a town life, although it is one of the "common objects of the country" in most parts of the *mofussil.* According to Stuart Baker, in North Cachar it ascends the hills to 2,200 feet. The Cattle Egret (*Bubulcus coromandus*), as its popular name implies, is an Egret which is especially attached to cattle—frequently accompanying these animals and feeding on the grasshoppers and other insects disturbed as the cattle move about and also picking off insects, ticks and leeches which are attracted to the cattle. It is a very tame bird, even coming into compounds where any cattle are grazing. It is a social bird, generally occurring in parties, accompanying the cattle in the fields and frequently perching on their backs. Sometimes it attends pigs also and relieves them of lice. Occasionally it accompanies

crocodiles and apparently picks leeches or other parasites off them, and sometimes it varies its diet with small fish, tadpoles and aquatic insects. The late C. W. Mason investigated the stomach contents of three birds at Pusa in December 1909 and found that they contained 166 insects, of which three were Carabid beetles which were classed as beneficial, three as neutral, and 160 as injurious, the majority of this last category comprising grasshoppers and flies. There is no doubt but that this bird is decidedly beneficial to the agriculturist in India, not only helping to keep down grasshoppers and other crop-pests, but reducing the numbers of blood-sucking pests which prey upon cattle.

The Cattle Egret is easily recognizable, being a pure white bird with a yellow bill and black legs during most of the year. In the breeding season, which is at the beginning of the rains, some hair-like yellowish plumes grow from the head, neck and back, as seen in the right-hand figure of our Plate; these nuptial plumes are orange-coloured on the head and neck, those on the back orange-buff varying to pinkish or brownish buff. In Bihar this plumage is assumed in April, but in the case of one colony which was breeding on some mango trees in August there were just as many birds in the pure white as in the usual breeding plumage.

Before legislation took place this Egret suffered the same fate as those with more valuable plumes, but now it appears to be much less molested. It is protected by law throughout the whole year in the Central Provinces, Bombay, Bihar and Orissa. United Provinces, Delhi, Madras, Burma, and Assam.

As noted above, the Cattle Egret is a social bird at normal times, contrary to the habit of most herons during the non-breeding season, and it is probable that this social trait is the direct result of its attendance upon cattle. At the breeding season, however, which is from June to August in regions watered by the South-West monsoon, November and December in the Carnatic, and April and May in Ceylon, this sociability is greatly accentuated and the Cattle Egret at this time breeds together in vast numbers, often in company with other Egrets, Pond Herons and similar marsh-loving birds, making a large untidy nest of sticks, built in a tree,

often in tamarind trees around village ponds, and laying three to five very pale greenish or bluish eggs, almost white, which vary much in size and shape but are typically rather broad ovals, somewhat pointed towards one end, and measuring on the average about 43 mm. long by 33 mm. broad.

Mr. J. MACKENNA, M.A., C.I.E., I.C.S.

BY

E. J. BUTLER, D.Sc., M.B., F.L.S.

On the 30th of April, 1920, Mr. J. Mackenna, M.A., C.I.E., I.C.S., vacated our editorial chair on his resignation of the post of Agricultural Adviser to the Government of India and Director of the Agricultural Research Institute, Pusa. By his resignation the "Agricultural Journal" has suffered a severe loss, and the Department has to regret the departure of a most distinguished and popular chief.

In his new appointment as Development Commissioner in Burma, he has taken up the highly responsible duties of the first post of the kind established in India, and it is gratifying to know that he will still remain in charge of the agricultural development of a considerable province of the Empire.

Mr. Mackenna's connection with the Agricultural Department extended over a period of 16 years from his first appointment as Director of Land Records and Agriculture, Burma, in 1904. Shortly after this, he attended the first meeting of the Board of Agriculture held at Pusa, in 1905, and, by his active participation in the discussions at this and subsequent meetings—he has attended nine of the eleven hitherto held and presided over three—has taken no small part in shaping the policy of the Department.

In Burma he was responsible for organising the Provincial Department of Agriculture which came into existence as a result of the policy of agricultural development initiated by Lord Curzon's Government in 1905. The first experts that started work on the

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ural Research Institute, Pusa.

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"Agricultural Journal of India,"
1913-14 and 1916-20.

improvement of Burmese agriculture, with the advantage of Western experience, did so under his control, and it is fitting that, now that a large increase in expert staff of Burma has been sanctioned and a second period of progress is in sight, he should be back in his old province to exercise a guiding influence over the development of its resources.

He was first called to the charge of the Imperial Department of Agriculture in 1913, when he acted as Agricultural Adviser for a year during the absence of Mr. Coventry on leave. He returned to assume substantive charge when Mr. Coventry retired in 1916, and he held the post until his recent resignation, except for a short period of a month in 1918 when he acted as Secretary to the Government of India in the Department of Revenue and Agriculture, and for six months last year when he was on leave.

This period was one of exceptional strain in the agricultural as in all other departments. During the worst years of the war and the subsequent period of stagnation and slow recovery, the staff was depleted down to the bare minimum required to prevent disorganization. That in the face of these difficulties progress has not ceased is in no little degree due to the optimism with which Mr. Mackenna continued to consolidate the position already gained and prepare for a further advance as soon as conditions again became favourable. It was impossible to hope to expand during those years, but it was possible to prepare for accelerated progress in the brighter times that were coming. The end of the war found him with plans matured or maturing for a large expansion of activities in almost every direction and he had the satisfaction of placing these before Government during the past few months.

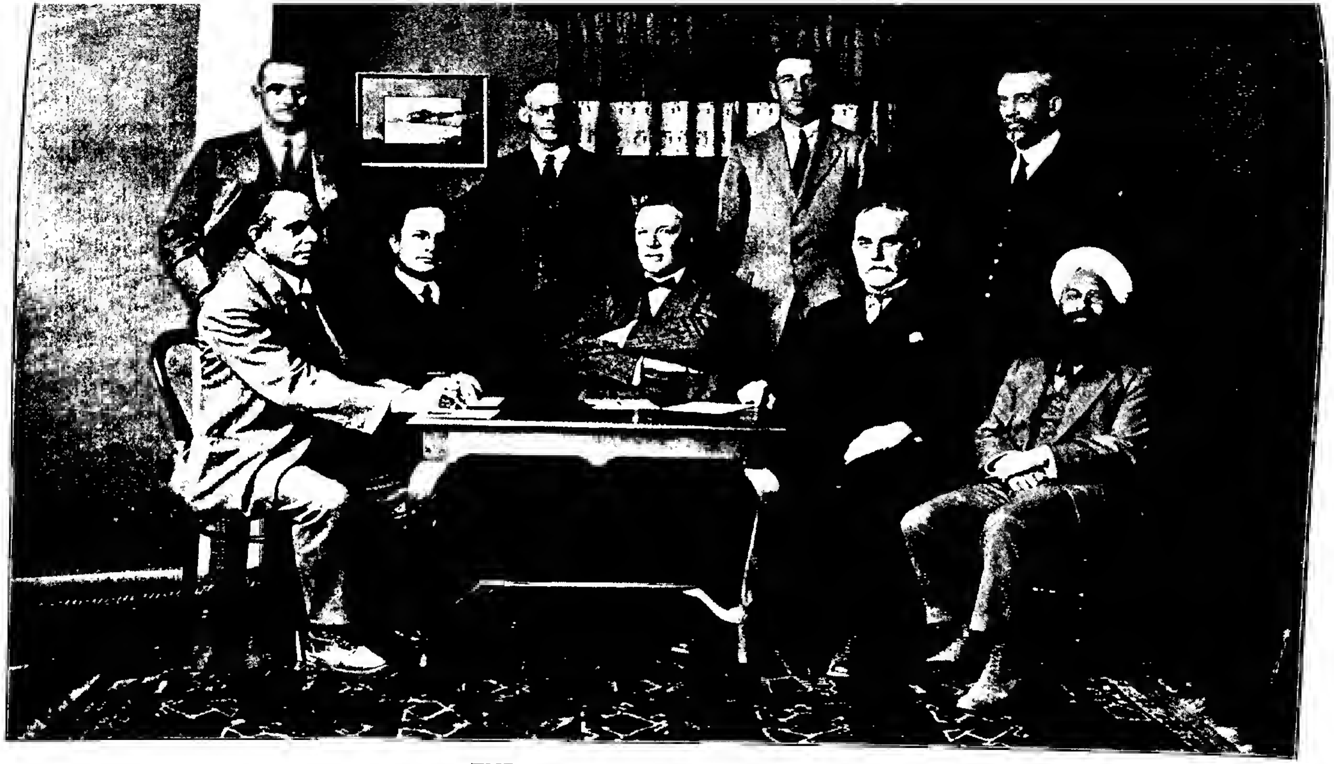
Post-war problems of great magnitude have to be faced in connection with some of our most important crops. The war very forcibly demonstrated the disadvantages of being dependent on foreign countries for supplies of the necessaries of life. Cotton and sugar are two of those commodities that the Empire produces in quantity insufficient for its needs, and in both cases India offers one of the most promising fields for development. Mr. Mackenna was instrumental in getting two strong committees appointed to

examine the Indian possibilities of expansion as regards these crops, and as President, first of the Indian Cotton Committee and then of the Indian Sugar Committee, he has spent a considerable part of the last three years in dealing with this question.

The Cotton Committee reported in 1918, and its recommendations have received a strong measure of support from bodies such as the Empire Cotton Growing Committee and the British Cotton Growers Association, as well as from the trade and agricultural authorities in India. They are far-reaching and will take a considerable time to give complete effect to, especially in the matter of securing the necessary staff to carry them out, but they are generally accepted as likely to be effective in improving the quantity and quality of the cotton grown in India.

The Sugar Committee was still sitting when Mr. Mackenna was summoned to Burma, and he had, therefore, to hand over its presidency to Mr. Noyce. Much of the Indian part of the enquiry was then completed and the evidence obtained is amply sufficient to show the need there was for a thorough examination of the position. Though India is one of the two chief producers in the world, there is little doubt that, but for the war, her imports of sugar would be now in excess of a million tons a year, and she is thus far from being in a position to feed herself, much less any other part of the Empire. But, with an area of some three million acres under the crop, it is clear that, if the Committee's recommendations are effective in stimulating the improvement of the present wretchedly low yield per acre, its work will have been of first-rate importance.

Another matter to which Mr. Mackenna devoted much attention was improving the publications of the Department. The "Journal" has greatly increased in popularity under his editorship and the recent decision to issue it every two months, instead of every quarter, should still further stimulate its circulation. His annual report on the Progress of Agriculture in India was regarded as, in many respects, a model for similar Government publications and was deservedly popular. In this connection, reference may also be made to his brochure on "Agriculture in India," where, in a


THE INDIAN SUGAR COMMITTEE

little over a hundred pages, he gives a lucid and interesting account of the work of the agricultural and allied departments up to 1915.

At Pusa, Mr. Mackenna will long be remembered as the most genial and kindly of chiefs. He did much to improve the amenities of life, always difficult in such an isolated place, and showed a practical interest in regard to recreational, medical and educational facilities for the staff.

For the Indian Agricultural Service he worked hard to secure the revision of the terms of service that he held were long overdue. Though he was not himself a member of the Service, he had its interests at heart, and it owes a great deal to his representations on behalf of its members.

We hope that he will not forget his old friends in the Agricultural Department as we know they will not forget him. There may still be opportunities for an occasional meeting and we foresee a further increase in the popularity of Burma as a scene for the touring activities of the Pusa staff. The best wishes of the Department accompany Mr. and Mrs. Mackenna to Burma, where, we hope, they will have a very successful and happy time

PRINCIPAL FODDERS IN THE CENTRAL PROVINCES AND BERAR, INCLUDING THE SMALL BAMBOO (*DENDROCALAMUS STRICTUS*).*

BY

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THE improvement in the breeding of Indian cattle in order to raise the standard of animal at the disposal of the Indian agriculturist involves also improvement in animal management, particularly as regards feeding. Stall-feeding is not only becoming possible but also necessary in some tracts ; and in future the farmer will have to provide fodder for his cattle instead of depending upon indiscriminate grazing.

A series of analyses of the common grasses of the Central Provinces and Berar made in the department's laboratory some time ago showed that these grasses are fundamentally low in feeding value. The analyses are sufficiently interesting to be worth quoting.

Composition of common grasses of the Central Provinces and Berar.

Name of grass	Moisture	Oil, etc.	Total nitrogen protein*	Soluble carbo-hydrate	Crude fibre	Ash†	*Including true protein	†Th[illegible]
Ischæmum sulcatum ..	7·38	1·38	3·56	35·75	35·35	16·58	3·19	[illegible]
Apluda varia ..	7·69	1·82	3·31	40·36	35·52	11·30	2·86	[illegible]
Setaria glauca ..	7·68	1·75	4·41	43·14	30·02	13·00	3·29	[illegible]
Iseilema laxum ..	1·16	1·25	2·89	46·98	31·13	10·59	2·41	[illegible]
Andropogon annulatus ..	10·34	1·76	2·69	43·57	33·18	8·46	2·00	[illegible]
,, *caricosus* ..	7·80	1·63	3·89	45·77	32·10	8·81	3·17	[illegible]
,, *pertusus* ..	10·57	1·83	3·95	47·48	28·62	7·55	2·39	[illegible]
Ischæmum laxum ..	8·84	1·20	2·97	42·82	34·01	10·16	2·35	[illegible]
Andropogon contortus ..	6·67	1·06	2·00	50·13	32·91	7·23	1·76	[illegible]
AVERAGE ..	8·24	1·52	3·30	44·00	32·54	10·41	2·60	[illegible]

* Paper read at the Seventh Indian Science Congress, Nagpur, 1920.

For purposes of comparison the following analyses of grasses grown in more temperate climates are given. The figures have been collected from various reliable sources.

	Ether extract	Total nitrogen as protein	Nitrogen free extract and soluble carbo-hydrate	Crude fibre	Ash
United States	3·14	9·21	53·97	25·71	7·97
Germany	2·31	10·74	46·53	34·09	6·30
Queensland	1·93	13·39	49·73	22·53	12·42
New South Wales ..	2·14	9·03	52·81	29·35	6·67

It is clear from a consideration of these figures that in so far as chemical analysis is a guide, the feeding value of Central Provinces and Berar grasses is much below that of the grasses produced in the countries named, particularly with regard to the highly important protein matter. Some of the local grasses have, however, a distinct reputation for feeding purposes, *Ischæmum sulcatum* being sufficient in itself to keep horses and cattle in good condition.

That present methods of chemical analysis are inadequate to deal with the relative values of pasture grasses is generally agreed. Figures given by Wilson[1] show practically no difference in the composition of grass from poor low rented pasture and that from valuable fattening land. Hall and Russell[2] arrive at the same conclusion in their study of the fattening pastures of Romney Marsh. More discriminating methods of analysis are obviously required, for although a food may contain a sufficiency of mixed protein, it is only of limited value if some necessary specific protein is absent. Further, the estimation of the digestibility of food is full of difficulties, and even when this factor has been determined more or less satisfactorily we are confronted with the question whether the digested portion of the food is entirely or only partially available for animal nutrition.

[1] *Science Progress*, Vol. VII, No. 27, p. 126.
[2] *Journ. Agri. Science*, Vol. IV, p. 339.

In considering the composition of Indian fodders, however, we are not at present dealing with the finer points of digestibility and availability so much as with the fact that in order to obtain its necessary daily ration of protein an animal has to consume about twice as much Indian fodder grass as would be required if the grass came from a more temperate country. It has been found that the quality of a fodder is susceptible to climatic changes, while Crowther and Ruston[1] in their investigation of the ripening of grass for hay found that poverty in protein was characteristic of fodder grown in dull cool weather.

In view of the apparent poverty of Indian grasses, any other fodders which can be grown easily are deserving of attention. Leguminous fodders are particularly valuable, even the wild bulky legume *Alysicarpus rugosus* has a total protein content of over 13 per cent. The cultivated leguminous fodders like lucerne (*Medicago sativa*), Egyptian clover or *berseem* (*Trifolium alexandrinum*), etc., are naturally of the greatest value where they can be grown, but the fact that they are not found to seed locally militates against their general adoption.

Of the bulky fodders commonly fed to cattle in the Central Provinces and Berar, rice and wheat straw and *juar* stalks are the most important. Many other fodders have been tested on Government farms in the provinces; but with the exception of Egyptian clover (*Trifolium alexandrinum*) and the small bamboo (*Dendrocalamus strictus*) none of them has shown much promise of being suitable for adoption on a large scale. Egyptian clover or *berseem* does best when sown in rice fields about ten days or a fortnight before that crop is harvested. When the monsoon ceases in September, it does well when sown in a standing crop of early rice early in October; but if the rains are more prolonged, it does better if sown later in fields carrying medium or late rice. To secure uniform germination it is all important that the seed should be sown while the surface soil is still damp. By lying in contact with moist soil the seed germinates in four or five days, and the young clover

[1] *Journ. Agri. Science*, Vol. IV, p. 305.

PLATE XXI.

Fig. 1. Young bamboos three years after planting.

Fig. 2. Cattle being fed with bamboo leaves.

plant is well established in about ten days, by which time the rice can be harvested. Clover sown in standing rice does better than that sown in open fields which have had to be cultivated before sowing. This would appear to be due to the fact that in its early stages the young clover plant does better when shaded from the hot glare of an October sun.

The seed rate required for clover broadcasted in standing rice fields is 40 lb. per acre. Within six weeks from the time of sowing the crop attains a height of about 15 inches. If cut at this stage, there will be a second growth ready a month later. Cuttings of from three to four tons per acre can be obtained every month from December till April, if the land is kept slightly moist by irrigation. The best time to irrigate is immediately after cutting. It is very responsive to manuring and it has been observed that when its cultivation is continued on the same land its outturn increases gradually. This may be due to the increase of nitrogen-fixing bacteria in the soil, or to the manurial value of the roots left behind, or to both. As a fodder it is easily the best of those which have been tested up to date in the Central Provinces. If it were possible to raise seed locally, the crop would undoubtedly have a great future; but under existing conditions the yield of seed per acre is only from 60 to 80 lb.

For poor light soils which cannot be irrigated, small bamboo (*D. strictus*) promises to be a most useful fodder, more especially in years of drought. Sir George Watt in his Dictionary of the Economic Products of India describes this bamboo as being densely tufted and gregarious, and as having strong and more or less solid culms of from 30 to 50 feet in height. It occurs on moderately dry hills throughout India and Burma, except in Northern and Eastern Bengal and Assam. It flowers after about 30 years; and after flowering the plants die. This bamboo does very well on the poor gravelly soils of the rice tract of the Central Provinces where the rainfall ranges from about 45 to 60 inches per annum.

Plate XXI, fig. 1, shows the height attained in three years by bamboos grown on "mooram" soils on the Chandkhuri Farm, Raipur. The seedlings were raised in an irrigated nursery and planted out in

the beginning of the rains. The first cutting taken in June after three years' growth yielded 19½ tons of green fodder per acre which was much relished by the farm cattle as will be gathered from Plate XXI, fig. 2. Though the tender twigs and green leaves of the older culms were removed from time to time during the rains no apparent injury was done to the culms. From the outturns already obtained, there is reason to believe that yields of from 40 to 60 tons of leaf per acre can be obtained from this variety of bamboo three years after planting. The analyses of the leaf both in the dry and green state made by the Officiating Agricultural Chemist are given in the statement below. Some analyses of other locally grown fodders are also given.

TABLE II.

Name of fodder	Moisture	Ether extract	Total nitrogen as protein	Soluble carbo-hydrate	Crude fibre	Ash*	*Including sand
1. Bamboo leaves, green, *D. strictus* ..	66·07	0·97	6·24	12·75	9·45	4·42	3·58
2. Bamboo leaves, air-dry, *D. strictus* ..	7·80	2·22	12·93	38·06	24·18	14·81	12·05
3. Bamboo leaves, green, *B. arundinacea*	63·48	0·89	3·96	16·25	10·32	5·10	3·85
4. Bamboo leaves, air-dry, *B. arundinacea*	6·86	2·26	10·09	41·46	26·32	13·01	9·81
5. Lucerne, *Medicago sativa*, dry ..	6·09	2·02	15·20	13·30	23·83	9·56	6·53
6. Berseem, *T. alexandrinum*, green ..	81·63	0·51	3·22	8·26	4·00	2·38	6·15
7. *Juar* fodder, *Andropogon Sorghum*, dry	6·14	0·89	2·89	58·42	25·37	6·29	3·08
8. Average fodder grass, dry ..	8·24	1·52	3·30	44·00	32·54	10·11	7·80

It will be seen that of the most important constituents of food, *viz.*, protein, oil and carbohydrate, dry bamboo leaves contain

nearly four times as much protein as is contained in the common grasses. The proportion of sand is somewhat high in both, and the proportion of indigestible fibre is greater in grasses than in bamboo leaves. The nutritive value of bamboo leaf appears to be at least equal to that of our grasses, while the yield obtained per acre is very much greater than that obtained from grass on similar soil. For the first cutting taken in June last year the variety *Dendrocalamus strictus* gave, as already pointed out, a yield of $19\frac{1}{2}$ tons per acre on the Chandkhuri Farm. Spear grass (*Andropogon contortus*), which is commonly found on this poor class of gravelly soil at present, ordinarily gives from $1\frac{1}{2}$ to 2 tons of green fodder per acre, which is equivalent to from 350 to 700 pounds of dry grass. It should be possible in parts of India where tracts of poor land are available and where the rainfall is suitable, to establish bamboo fodder reserves from which useful supplies of green fodder could be obtained for 7 or 8 months of the year, and from which bamboo hay could be made for utilization in years of fodder famine. That bamboo hay is a palatable fodder for cattle has been proved on the Telinkheri Dairy Farm, where an experiment is now being carried out to compare its feeding value with that of dry grass. In the green state it is already used as a fodder in certain parts of India. In this state it is supposed to possess medicinal properties and is commonly fed to ponies and cattle suffering from ailments such as "broken" wind and foot-and-mouth.

There are many other uses to which this bamboo could be put: its seed is a most welcome food-grain and its tender culms a welcome vegetable in famine years. Its mature culms are used as rafters and battens, or in the manufacture of mats and furniture. In jungly areas where bamboos are plentiful and where pigs abound, the cultivator fences his cane and vegetable plots with a fence made of split bamboos. There is, in short, good reason to believe that the systematic cultivation of this most useful species is well worth the serious consideration of the Department of Agriculture in this country.

SOME FACTS AND FIGURES REGARDING BANANA CULTIVATION.

BY

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AND

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The following facts and figures are culled from a mass of records of two plantations in the Ganeshkhind Botanical Garden, and may be of some use in giving more accurate information regarding this important crop.

Two varieties were used. In the first plantation was planted a variety locally known as *Soni,* with a medium-sized, very sweet, yellow-skinned fruit. The area of the plot was 23 *gunthas,* that is 23/40ths of an acre. The suckers were put in at 15 feet apart each way, and were 110 in number. The main objects of this plantation were to provide material for

(1) observation of the development and morphology of the inflorescence and flowers of the banana;

(2) study of the problems of pollination, fertilization, and hybridization.

Incidentally other observations were made or recorded in the cultivation sheets, and it is these that are here presented in a highly condensed form.

It should be mentioned that this work passed through the hands of no less than three assistants and hence there was some little trouble in disentangling facts from the records, but the statements now made are sound.

The plantation was destroyed in March 1919. The total yield of raw fruit for the plantation from June 1915 to this date was as follows:

	Yield	
	for 23 *gunthas*	calculated per acre
Weight	15,637 lb.	27,194 lb.
Number of fruits	81,066	140,984

The original sucker we called the mother-sucker, and the following suckers that came into bearing on the same stool we called the first, second, etc., sucker-generation. Suckers were cut away from the stool at first so as to leave one in bearing, one half-grown and one just starting. Later on this rule was not strictly observed. The total number of suckers that came into bearing during the time of the experiment was 494, representing the mother generation and up to three sucker generations after it.

The average yield per sucker (mother or daughter) during the period of experiment was 31·65 lb. in weight or 164 fruits in number.

A manurial experiment was carried out, the plot being divided into two, one part treated with a mixture recommended by Dr. Mann and the other receiving local treatment. Later on both plots received the same treatment. The following are the dates and methods of manuring, the quantities given are per stool:—

June 21, 1915 ..	Both plots received 80 lb. farmyard manure per stool, at time of planting.
June 26, 1916 ..	Sub-plot 1 received 20 lb. poudrette and 1 lb. Dr. Mann's formula, and Sub-plot 2, 40 lb. poudrette.
Jan. 11, 1917 ..	Do. Do. Do.
	(Manurial experiment ended.)
Feb. 9, 1917 ..	Both plots received 140 lb. farmyard manure and one lb. bone meal per stool.
June 1, 1917 ..	Do. Do. 100 lb. poudrette.
Jan. 23, 1918 ..	Do. Do. 100 lb. poudrette.

The manurial experiment has been recorded in the Annual Report of the Ganeshkhind Botanical Garden for the years 1915-16, 1916-17, and 1917-18 and in Bulletin No. 89 of the Bombay Agricultural Department. There is no need to say more of it here than to state that the poudrette plus Dr. Mann's formula proved the better treatment.

Watering was done at ten-day intervals.

The attached table is a record of the behaviours of three stools (numbers 14, 46, and 77) taken at random in the whole plantation.

Tree No.	Date of harvests	No. of days between harvests	Weight of fruit produced	No. of fruits produced	Fluctuation
			lb.		
14 mother	1-11-16	1 year and 130 days from planting.	18	130	..
A gen.	13-9-17	312	28	183	+53
B „	1-7-18	288	36	218	+35
46 mother	23-9-16	1 year and 92 days from planting.	24	154	..
Sister suckers { A gen.	15-5-17	232	31	172	+18
Sister suckers { A „	7-8-17	82	60	207	+35
Do. { B „	25-5-18	288	44	230	+23
Do. { B „	24-6-18	30	53	216	−14
77 mother	31-8-16	1 year and 70 days from planting.	8	104	
Do. { A gen.	5-4-17	215	18	248	144
Do. { A „	8-4-17	3	41	253	+5
Do. { A „	7-8-17	119	25	145	−108
Do. { B „	11-5-18	274	16	157	+ 12
Do. { B „	1-6-18	20	50	203	+ 46
Do. { B „	13-6-18	12	40	228	+ 25
Do. { B „	14-7-18	31	52	180	−48

On examining the above table we see that from the date of planting to the date of fruiting of the bunch the average

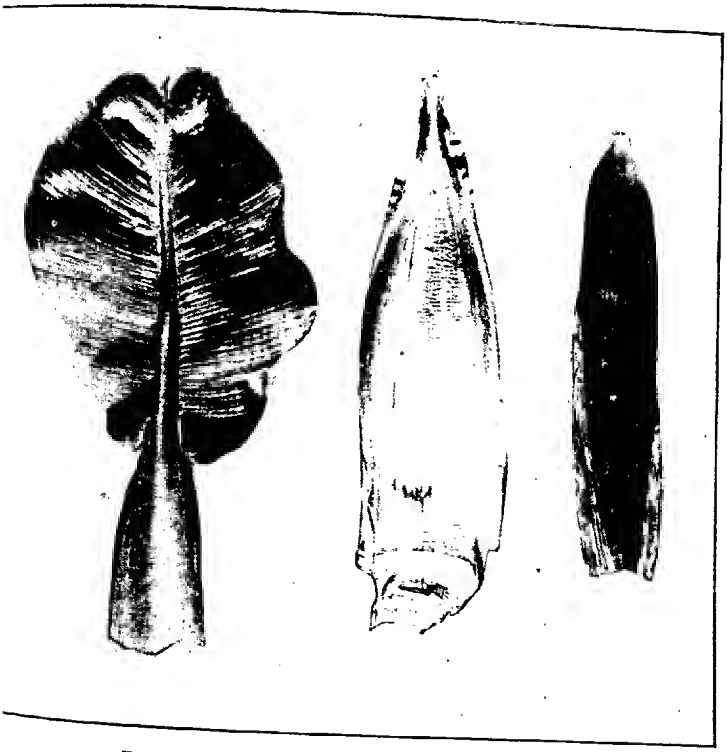
number of days required is one year, three months and seven days.

From the date of harvest of the mother to that of next generation the interval is 280 days.

The same from A to B is 298 days.

The yield in the first generation is more by an average of 72 fruits than that of the mother, and is still more by an average of 3 in the second generation than the first. (Here the average of three stools is taken.)

The appearance of the inflorescence is always heralded by the appearance of leaves which we have named *transition* leaves, intermediate between a foliage leaf and a bract. The text-figure shows their appearance.



Transition leaves 1 and 2, and first bract of a banana plant.

The average interval between the appearance of the first transition leaf and the harvesting of the bunch was as follows :—

	No. of trees averaged	No. of days
Mother generation	23	121
Sucker "	9	156
" "	4	153
" "	4	166

The second plantation consisted of plants of the *Rajeli* variety from Walhe village on the Madras and Southern Mahratta Railway. This variety is elsewhere known as *Rajapuri* or *Gujarathi*. This is a variety more dwarf in habit and with a more angled and slightly coarser fruit than *Soni*. The area planted was 8 *gunthas* (8/40ths of an acre) and the distance between trees each way was 11 feet. The total number of trees was 72. The plantation was begun on July 8, 1916, and destroyed in the beginning of March 1919.

The total yield for the whole plantation during its existence was :—

	Yield	
	for 8 *gunthas*	calculated for one acre
Weight	4,687 lb.	23,085 lb.
Number of fruits	17,210	86,050

The average number of sucker generations per stool was two. The average yield per sucker was 21·27 lb. or 79·30 fruits. The manurial treatment was as follows :

July 8, 1916 .. 50 lb. of poudrette per stool, at the time of planting.

June 1, 1917 .. 100 lb. of poudrette per stool.

Watering was done at ten-day intervals.

Taking three stools at random (Nos. 24, 32, and 49), the following are details regarding time of fruiting, etc :—

Tree No.	Date of harvest	No. of days between harvests	Weight of fruit produced	No. of fruits produced	Fluctuation
			lb.		
24 mother ..	31-7-17	1 year and 23 days from planting.	40	114	
A gen. ..	20-4-18	260	70	151	+37
B „ ..	5-8-18	105	29	130	−21
32 mother ..	25-8-17	1 year and 47 days from planting.	40 lb.	88	
A gen. ..	27-4-18	242	24	102	+14
B „ ..	10-9-18	133	18	79	−23
49 mother ..	13-9-17	1 year and 65 days from planting.	16	64	
A gen. ..	3-5-18	230	50	149	+85
B „ ..	21-2-19	288	19	62	−87

On examining the foregoing table we see that from the date of planting to the date of fruiting of the mother plant the average number of days required is one year and 45 days.

The interval between dates of successive harvests is—

an average of 244 days from mother to first generation, and
„ „ „ 119 „ „ first to second generation.

As to yield there is an average increase of 46 fruits in the first sucker generation and an average decrease of 44 fruits in the second generation.

The following calculations show the probable profits from the cultivation of the *Soni* variety in the Poona District.

Cost of cultivation.

Cost of labour :—man charged at the rate of 8 as. per day.
woman do. do. 4 as. do.
child do. do. 4 as. do.
bullock do. do. 4 as. do.

Farmyard manure at Rs. 2 per cart and poudrette at Rs. 2-4-0 per cart.
Two cart-loads are equal to one ton (2,240 lb.)
One basket is equivalent to 20 lb.
56 such baskets make one cart-load.

(The whole time of the existence of the plantation is taken as three years and six months. The following are calculated per acre.)

EXPENDITURE.

No.	Operations, &c.	Rs.	A.	P.
1	Two ploughings crosswise by an iron plough CT_2 or Arlington, two pairs and two men for 4 days ..	8	0	0
2	Disking and harrowing, one pair and one man for the whole day ..	1	8	0
3	Digging pits: size $2\frac{1}{2}' \times 2\frac{1}{2}' \times 2\frac{1}{2}'$. Pits required for an acre 15 feet apart are 193. One man digs 5 pits in one day, 39 men finish the work in one day ..	19	8	0
4	Suckers required 200, at the rate of Rs. 10 per 100 ..	20	0	0
5	Manuring at the time of planting, F. Y. M. 80 lb. per plant (14 cart-loads required) ..	28	0	0
6	Carting manure at R. 1 per cart ..	14	0	0
7	Planting suckers; one man plants about 25 suckers in one day ..	4	0	0
8	Harrowing and levelling after planting ..	1	0	0
9	Preparation of beds and water channels, one man prepares about 16 beds of the size required per day ..	6	0	0
10	Irrigation charges: water generally given for 10 months in a year excepting rainy season; 30 waterings in all for one year. Irrigation Department charges per acre Rs. 22-8-0 for crop like plantain (G. R. No. 6371, dated 27th June, 1917), for three and half years ..	78	12	0
11	Watering charges; in all 105 waterings for the whole time of the plantation; one man can irrigate one acre in a day ..	52	8	0
12	Stirring, digging and weeding the beds once every three months. 12 men can finish it in one day. 14 such operations ..	84	0	0
13	MANURING:—Generally manured every six months. For the method of manuring as described above on page 387 the total cost comes to..	173	10	0
14	Land assessment to Government for three years at the rate of Rs. 4 per acre ..	12	0	0
15	Rent of land on lease for three and half years at the rate of Rs. 20 per acre ..	70	0	0
16	Harvesting charges; per bunch 3 pies, for 868 bunches ..	13	9	0
	Total cost ..	586	7	0
	INCOME.			
	Yield per acre in number of fruits, 140,984; sold wholesale on the plot itself at Rs. 10 per 1,000 ..	1,409	13	0
	Subcrop like chillies, etc., taken for the first six months. The net profit per acre for such a crop comes to..	50	0	0
	Spare suckers sold at the rate of Rs. 10 per 100 ..	52	0	0
	Total income ..	1,511	13	0
	Deducting cost of cultivation ..	586	7	0
	We get a net profit for three and half years ..	925	6	0
	So, for one year, the net profit for banana cultivation is ..	265	0	0

SOME NOTES ON COTTON IN SIND.

BY

K. I. THADANI, B.Ag.,
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The economic significance of natural crossing is a matter of the first importance, as it affects the improvement and introduction of varieties and also distribution of seed. Hence it is worth while to estimate the extent to which it occurs and also to find out an efficient means of protection against it. Professor Gammie, from the failure of emasculated flowers exposed to natural crossing to fertilize, was led to believe that Indian cottons were normally self-fertilized, but the most reliable method of obtaining accurate information on the subject should be based on a study of single plant cultures.

During the course of the writer's selection work on the local cotton (*Gossypium neglectum*) in Sind, he has been dealing with a large number of single plant cultures for the last few years, and the record of the examination of their progeny may give a clue to the present inquiry. The local cotton in Sind is composed of four varieties, two with white flowers, namely, (1) *Neglectum rosea* and (2) *Neglectum cutchica*, and two with yellow flowers, namely, (3) *Neglectum vera* and (4) *Neglectum malvensis*. It has been shown by Leake and corroborated by Fyson that white colour of the petals in the cotton flower is recessive while yellow is dominant. If that is so, the extent of natural crossing can be determined with certainty from the behaviour of the progeny of the white-flowered plants exposed to natural crossing; while the examination of the progeny of the yellow-flowered plants will not help much, as the

first generation hybrids always assume the dominant form and thus escape detection.

In the year 1915-16, sixty-four white-flowered plants were marked in an ordinary field where all forms were growing mixed. Each was picked separately, sown next season in line culture and the progeny examined. Three cultures were lost and the detailed results of the remaining sixty-one cultures may be summarized as under :—

Variety	No. of single plant cultures	No. of cultures breeding true to type	No. of cultures splitting	Percentage of plants affected by natural crossing
Neglectum rosea ..	34	6	28	84
Neglectum cutchica ..	27	8	19	70

In the year 1916-17, fifty white-flowered plants were similarly marked in a mixed field, separately picked and sown next season in line cultures. The detailed results of the examination of the progeny are summarized as under :—

Variety	No. of single plant cultures	No. of cultures breeding true to type	No. of cultures splitting	Percentage of plants affected by natural crossing
Neglectum rosea ..	28	6	22	79
Neglectum cutchica ..	22	5	17	77

Similarly, the selection of ninety-nine white-flowered plants in the year 1917-18, sown next season, gave us the following results :—

Variety	No. of single plant cultures	No. of cultures breeding true to type	No. of cultures splitting	Percentage of plants affected by natural crossing
Neglectum rosea ..	49	19	30	60
Neglectum cutchica ..	50	14	36	72

The results of the selection of 1918-19 are as under :—

Variety	No. of single plant cultures	No. of cultures breeding true to type	No. of cultures splitting	Percentage of plants affected by natural crossing
Neglectum rosea ..	36	16	20	55
Neglectum cutchica ..	10	5	5	50

The results show that vicinism causes from 50 to 84 per cent. of the plants to become affected by natural cross-fertilization. The percentage would be still higher if we were to take into consideration fertilization between sister plants which remain undetected. It has been further found that one plant bears on an average twenty flowers and that the affected plant gets on an average two of its flowers naturally crossed. At that rate the percentage of natural cross-fertilization would amount to from 5 to 8·5 per cent.

Since natural crossing is annually occurring and is a permanent source of trouble, confusion, and error, any practical means of protection against it would be simply invaluable not only from economic considerations, but also in solving genetic problems. In all line cultures, specially in Mendelian work, covering of the plants or the flowers is an absolute necessity. Several devices are resorted to, such as paper covers, muslin bags, nets, rings, sutures, etc. Whatever the device, the labour involved is considerable and there is always a certain percentage of flowers that do not set. Further, Mr. Leake found that the effect of continued covering leads to sterility. Apart from this, the application of these devices is limited to small cultures, being of no avail for cultivation on a field scale where roguing and insolation are the only means of protection.

During the course of the writer's observations on the cotton flower he chanced upon a flower which was marked (among several others) at 10 o'clock in the morning, when it was a full bud, for the purpose of recording the exact time when it would open. After two hours the bud was very much swollen but the tip was

completely sealed, maintaining the shape of the bud, while other flowers had opened their petals wide apart. The particular flower was kept under observation, every hour until evening, but the petals never opened; the bud began to shrivel from 2 o'clock, showing that fertilization had taken place inside. Observations were continued till the next day, but the petals did not open as was expected from the shrivelled appearance of the closed petals on the previous day. It was then properly marked and labelled for collection of seed. When the boll was formed a small bag was put on lest cotton should drop on the ground when the boll burst. The same evening while rambling in his cotton plots the writer found some fertilized flowers with closed petals as distinct from those that had opened as usual. The circumstances led to the search of some more cleistogamic flowers and the writer was able to find about a dozen and a half on which observations were taken during the full course of a day. It may be further remarked that the plants on which cleistogamic flowers were discovered had mostly opened all the flowers except the one closed flower that was found. The case is analogous to that of Nilsson who discovered that in pure lines of oats occasional grains appear that are aberrant either in colour or morphological characters. The variations tested by him either bred true at once, or after one or two generations practically all of the progeny bred true to the character.

Now it remains to be seen if this character is hereditary or if it can be fixed. The very existence of cleistogamic flower suggests that a race could be bred in which the flowers would admit no crossing. In conclusion, the writer is reminded of a passage from Balls who, while describing the various means of protection against natural crossing, says:—

> "Another obvious possibility is the discovery or manufacture of a cleistogamic flower which shall absolutely refuse to admit foreign pollen to its style. At one stage of these researches the author seemed to be well on the road to success in this direction and the story of ultimate failure is not without suggestiveness."

Failing to find anywhere a hint of the existence of uncrossable cotton flowers, Balls was led to experiment on a short style flower in which the opportunity of foreign pollen to reach the style was small, and came to the conclusion that the accessibility of the style was a minor factor in natural crossing under the conditions of our breeding plot.

STUDIES IN BIOCHEMICAL DECOMPOSITION OF COW-DUNG AND URINE IN SOIL.*

BY

N. V. JOSHI, B.A., M.Sc., L. Ag.,
Offg. Assistant Agricultural Bacteriologist, Pusa.

In a previous paper on nitrification of green manures, read at the last Science Congress, by the writer, it was shown that certain plant tissues, *e.g.*, stems and roots, fail to nitrify in soil, even under optimum conditions of temperature and moisture, and also as a result of further experiments it was suggested that "the failure to nitrify, so far as ascertained, does not depend on the nature of the nitrogenous materials. It is probably due to nitrate reduction occurring in the presence of great quantities of non-nitrogenous materials, such as cellulose and woody tissue." In order to find out whether and, if so, how far this explanation is applicable in the case of other organic nitrogenous materials, experiments with a number of different manures like oil-cakes, cattle-dung and urine, and sheep-fold manure, etc., were initiated, but as it would unduly lengthen the paper if we were to deal with all the substances examined at one time, it is proposed here chiefly to deal with the trials made separately with cattle-dung and urine only. These two materials are of the greatest importance to the agriculturist, especially in India, as they form principally the only sources of manure to the small cultivator in this country where practically no artificial manures or oil-cakes are employed in the usual farm practice, except by planters or rich cultivators. It will perhaps be asked at the outset why experiments with farmyard manure direct were not so far carried out, since farmyard manure

* Paper read at the Seventh Indian Science Congress, Nagpur, 1920.

is the most commonly used manure all over the world, and both the materials experimented with, *viz.*, cattle-dung and urine, are associated together in the farmyard manure as its chief constituents. It may be pointed out, however, in reply that the work on farmyard manure is complicated by the fact that this manure undergoes several chemical and bacterial changes during storage and further the quantities of dung and urine which are added in different places while making up the farmyard manure are subject to such a wide variation that no useful purpose would have been served by taking up the study of farmyard manure at once; especially as it was considered that more useful information could be obtained by studying, in the first instance, the decomposition of the two materials—dung and urine—separately, either before or after fermentation. Besides, the study of the decomposition of these substances separately was more suited to our purpose as the difference in the chemical composition of these substances is already known. The urine of animals contains nearly all the potash and a good deal of nitrogen with only a very small amount of phosphate, while the non-nitrogenous material present is very much smaller as compared with dung which contains a proportionately larger amount of non-nitrogenous materials. The amount of phosphate voided with the dung is also comparatively larger. Moreover, the urine contains the plant foods not in solid form as in the case of the dung, but in solution. It was therefore proposed to see in the first instance which of these two substances in a fresh condition, *i.e.*, before fermentation, is more easily nitrified, as the knowledge whether any particular organic substance would readily decompose in a soil so as to be immediately available to the crop is likely to be very useful to the agriculturist.

The study of the decomposition of these substances after they were separately stored and had undergone fermentation was also further taken up as it was considered to be of practical value from the point of view of conservation of farmyard manure. Owing to fermentation and drainage, the loss from the manure kept in the ordinary way is a very serious item, and the problem of conservation of farmyard manure would be much simplified if it were

known which of these substances is responsible for the serious losses known to occur during storage of this manure. Although it is doubtful whether such a study will confer immediate benefits or solve the problem at once, the writer was led to undertake the investigation in the hope of getting some useful data. The results so obtained form the subject matter of the present paper and are presented here with a view to elicit useful criticism.

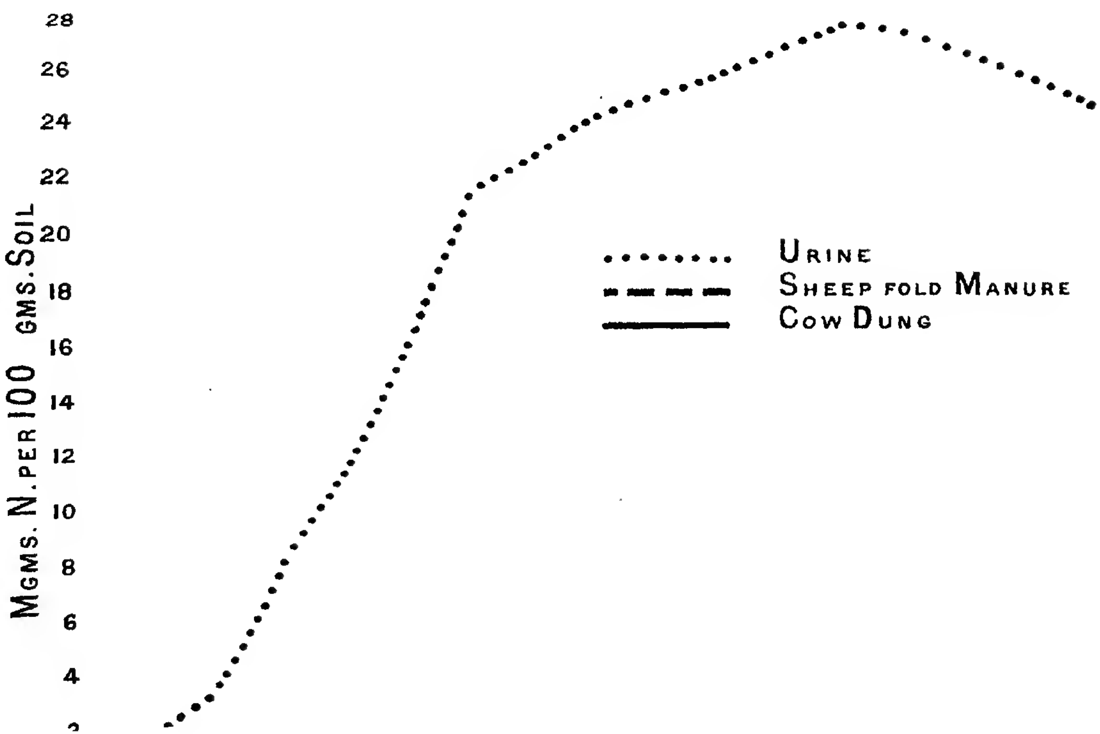
While studying the nitrification of cattle-dung and urine, it was the writer's original intention to study and compare the decomposition of sheep dung and urine, but it was not possible to arrange to get these separately. Only sheep-fold manure (*i.e.*, a mixture of dung and urine) was available. Trials with this are included here just to indicate what kind of results can be expected with the mixture of dung and urine obtained.

Cow-dung and urine and sheep-fold manure were brought to the laboratory in fresh condition and were immediately analysed for their moisture and nitrogen content. These being determined, they were then separately added to each kilo of air-dry Pusa soil at the rate of 30 mgm. of organic nitrogen per 100 grm. of dry soil (equivalent to 750 lb. of N per nine inch acre), water was added so as to make up the moisture content of the soil up to 16 per cent., allowance being made for the water already contained in the manures. The manures were then thoroughly mixed with the hand and each lot filled in separate glass bottles covered and kept at 30° C. in the incubator. It would be useful here to mention that the quantities of nitrogen and moisture stated above had been found to be optimum for the Pusa soil for nitrification and were therefore adopted in these experiments.

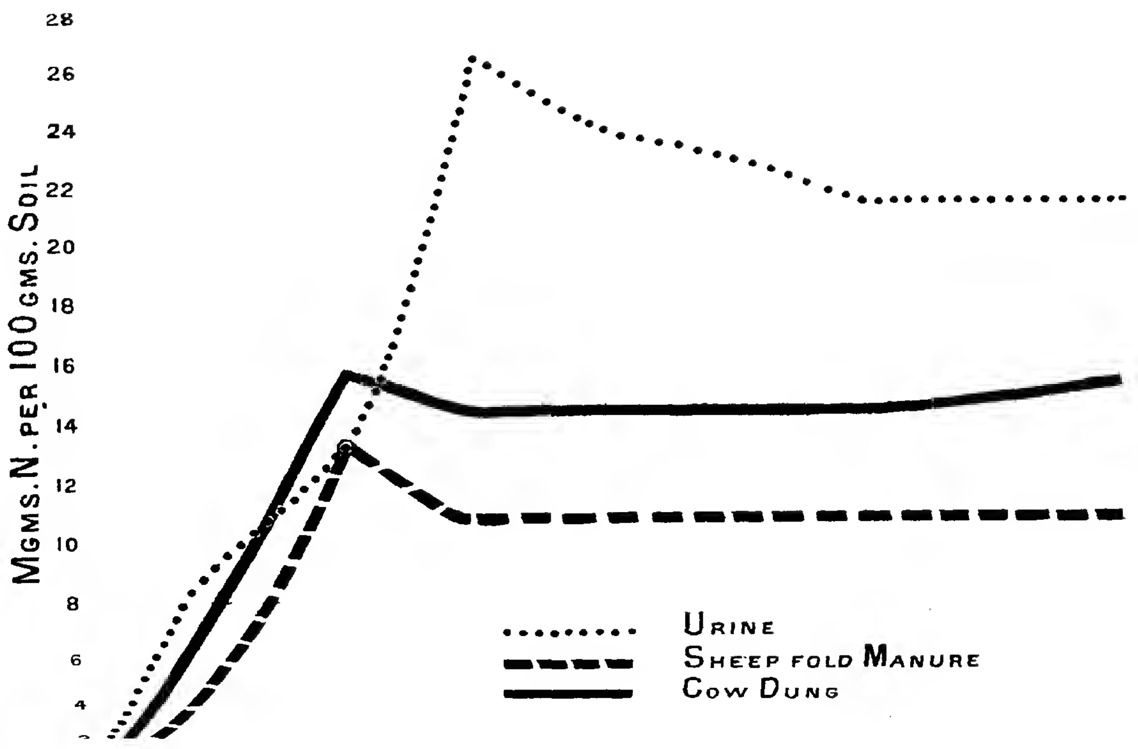
Samples for analysis were taken after thoroughly mixing the soil, to determine quantitatively the amount of ammonia, nitrite and nitrate formed at the end of each week for the first four weeks, after which time determinations were made at an interval of two weeks.

The methods of analysis were the same as those employed on the previous occasion.[1]

[1] Joshi, N. V. *Agric. Journ. of India.* Special Indian Science Congress No., 1919, p. 400.



Mgms. N. per 100 gms. Soil
28
26
24
22
20
18
16
14
12
10
8
6
4
2
Urine
Sheep fold Manure
Cow Dung



Mgms. N. per 100 gms. Soil
28
26
24
22
20
18
16
14
12
10
8
6
4
Urine
Sheep fold Manure
Cow Dung

In Chart I, the amounts of nitrates formed by the decomposition of cow-dung, urine and sheep-fold manure, as found by analysis, are plotted in the form of curves. It is clear that cow-dung does not show any nitrate formation. Urine shows the greatest amount of nitrates, while sheep-fold manure, which is a mixture of dung and urine, stands between the two. In the opinion of the present writer these results confirm the previous contention that the absence of nitrate accumulation (as in the case of cow-dung and sheep-fold manure) is due to the nitrate reduction occurring in the presence of great quantities of non-nitrogenous materials such as cellulose, since the nitrates are found to vary inversely as the amount of non-nitrogenous material. Cow-dung, which contains the greatest amount of non-nitrogenous material associated with the nitrogenous one, shows the least amount of nitrates; urine, which has the least amount of non-nitrogenous material associated with the nitrogenous one, has given rise to the greatest amount of nitrate; while sheep-fold manure is intermediate between the two, both as regards its non-nitrogenous content and the amount of nitrates found.

Since farmyard manure consists mainly of dung and urine which have undergone some changes, aerobic as well as anaerobic, in heaps or manure pits, it was proposed to see what effect the storage has on the decomposition of each of these materials singly with special reference to nitrate formation. For this purpose the materials left over after use in the first experiment and kept in open jars with clock glass covers were used. Fresh determinations of nitrogen and moisture content were made and the materials were then separately added to soil on the same basis—30 mgm. N per 100 grm. of soil as before. Chart II gives the results showing that while urine has retained its place as regards high nitrifiability, cow-dung and sheep-fold manure have exchanged places; cow-dung, after storage, is superior to sheep-dung, and further a greater amount of nitrogen has been transformed into nitrates both in the case of the stored cow-dung and sheep-fold manure than the amounts so transformed from these substances in fresh condition.

The results of one experiment were, however, considered insufficient proof, because it was realized that the composition of cow-dung is not uniform in all seasons and might also vary with the food given. Another experiment was therefore arranged on the same lines as before about four months after the first, and this time the addition of straw (which usually finds its way into the manure heap) was introduced as a variation, so that each of the materials used was tried, with and without straw, there being thus six bottles instead of three as in the previous two experiments. The straw added amounted to only 0·5 to 0·6 per cent. of the quantity of dung employed, although the amount of straw heaped together with cow-dung in the manure pit was estimated to be about 20 per cent. of the quantity of dung. This estimate is confirmed by the figures, kindly supplied by Dr. Mann, of one particular experiment lasting for one week made at the Poona Agricultural College Farm.

The figures are as follows :—

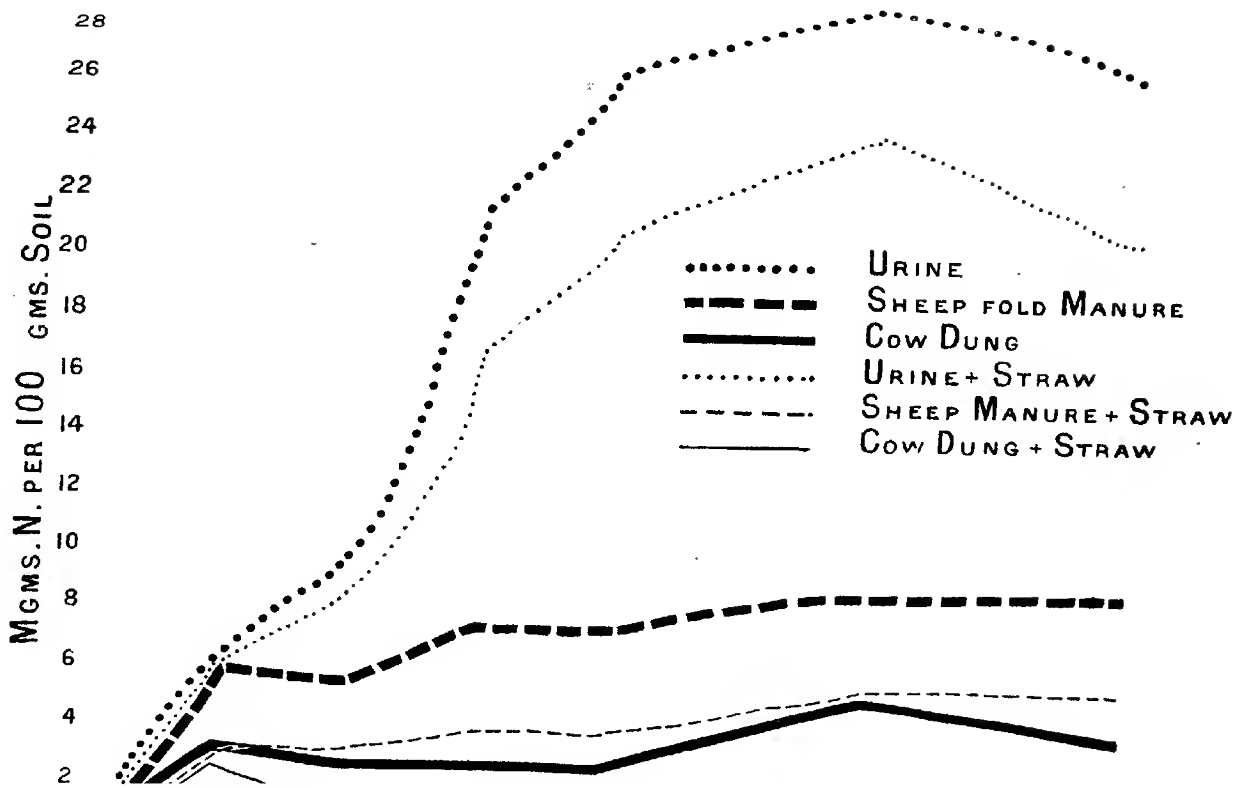
Cow-dung	.. .. ..	3,886 lb.
Straw	.. .. ..	862 lb.

which show that the straw is about 22·2 per cent. of the cow-dung.

The smaller quantity of straw was employed because in some other experiments it had been found sufficient to show its effects on the course of nitrification.

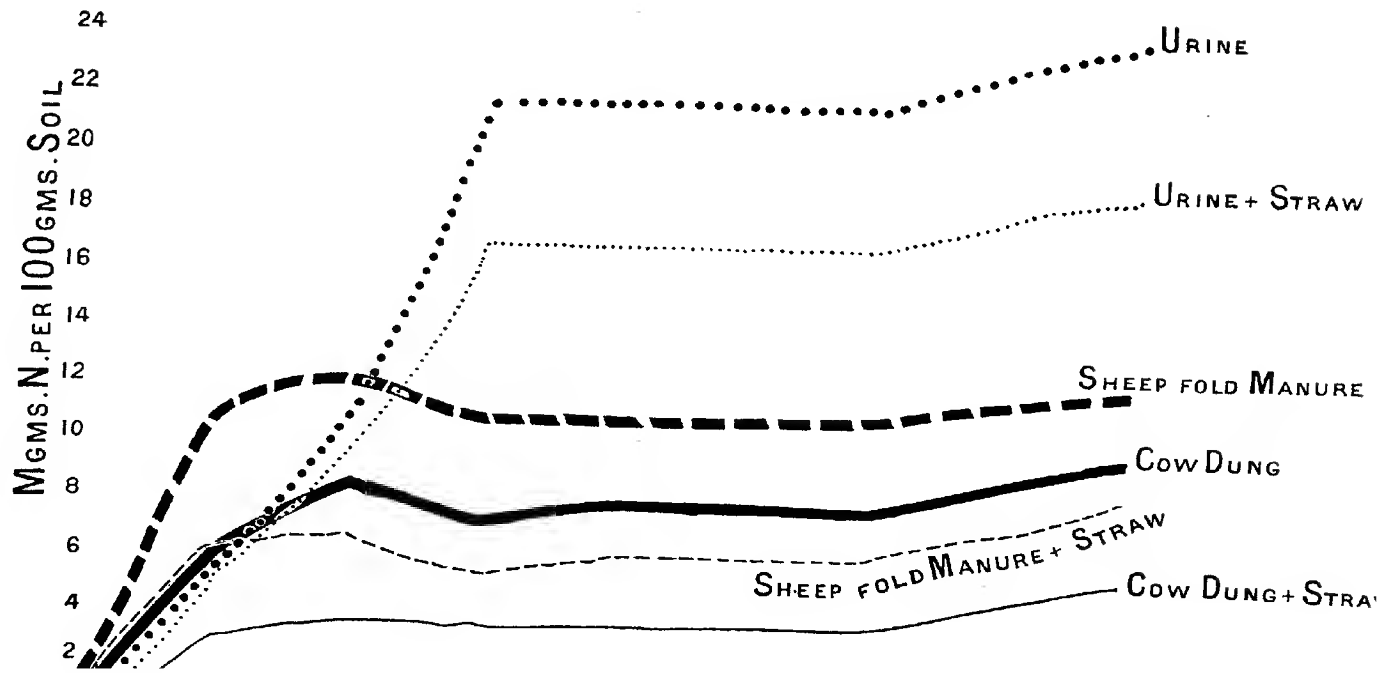
Chart III illustrates the results. It will be seen that they are of the same type as those obtained in the two previous experiments, and further that the addition of straw had the effect of lowering the amount of nitrate found in each case.

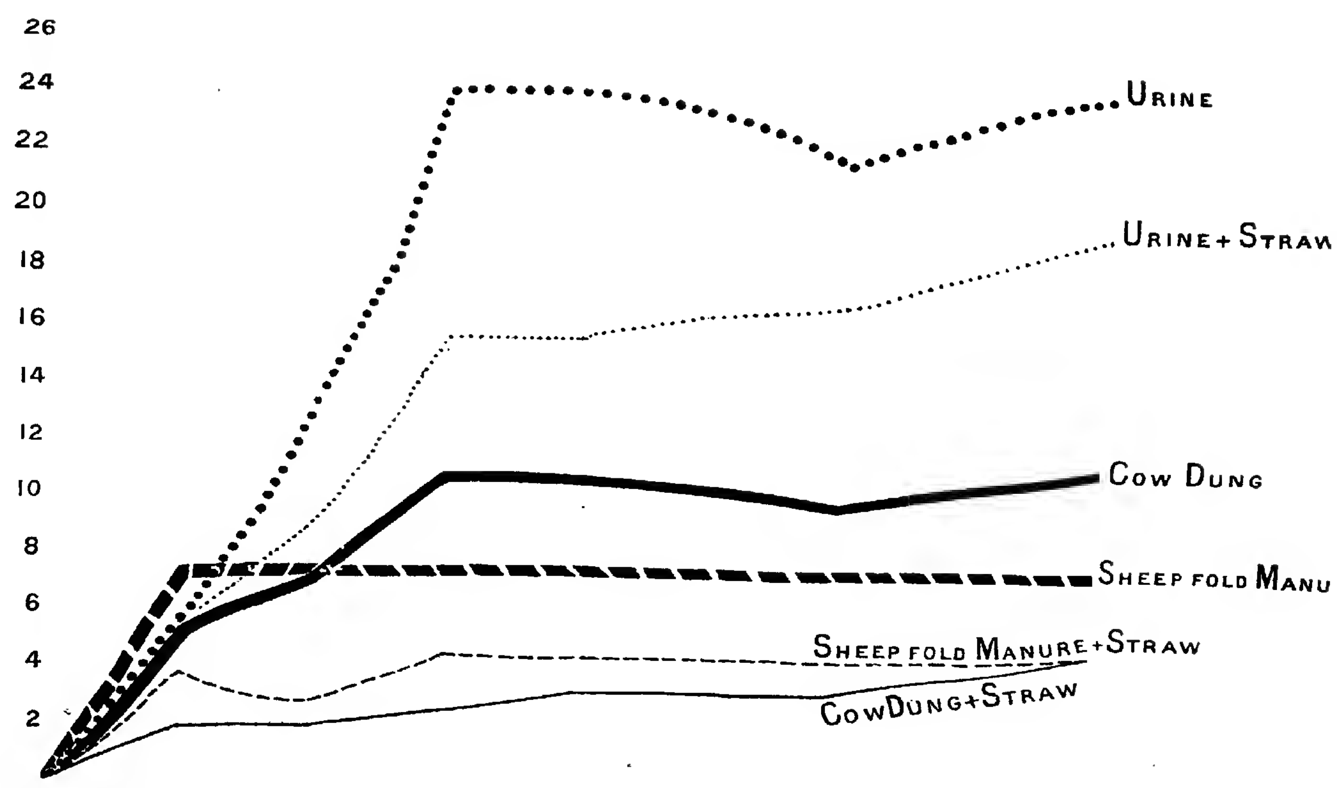
In order to see the effect of storage as in the previous case, cow-dung, urine and sheep-fold manure which had remained after use in the third experiment were divided each into two equal lots and each lot was stored in a separate jar. The jars were then divided into two sets. Jars in one set comprising one lot of each of these substances were covered with ground glass plates, which were then made airtight on the edges of the jar by rubber lute with a view to exclude the outside air, thus securing the storage of the materials under anaerobic conditions as far as possible. In the other set the jars had only paper covers and thus had access to



Mgms. N. per 100 gms. Soil
28
26
24
22
20
18
16
14
12
10
8
6
4
2
Urine
Sheep fold Manure
Cow Dung
Urine + Straw
Sheep Manure + Straw
Cow Dung + Straw

CHA


Mgms. N. per 100 gms. Soil
24
22
20
18
16
14
12
10
8
6
4
2
Urine
Urine + Straw
Sheep fold Manure
Cow Dung
Sheep fold Manure + Straw
Cow Dung + Stra


26
24
22
20
18
16
14
12
10
8
6
4
2
Urine
Urine + Straw
Cow Dung
Sheep fold Manu
Sheep fold Manure + Straw
CowDung+Straw

outside air; this set is therefore called "aerobic." No attempt was, however, made to pass the current of air over the materials in the aerobic set. Both these sets of jars were left at laboratory temperatures varying between 28° C. to 30° C. After a few months' storage under these conditions, the materials as fermented were taken out, their moisture and nitrogen content determined and then they were separately incorporated in the soil. The variation introduced by the addition of straw was retained in both cases. Other conditions of the experiment were also the same as before. The results are shown in two separate charts, Nos. IV and V. The aerobically fermented materials have practically given the same results as in the previous case, except that the sheep-fold manure gives slightly more nitrates than the cow-dung. In the case of the anaerobically fermented ones it will be seen that although urine retains its high place as regards its nitrifiability, the anaerobically fermented sheep-fold manure and the anaerobically fermented cow-dung have changed places. The straw has shown its effect, *viz.*, that of lowering the amounts of nitrates, in every case. Comparing the results of the two sets it may be observed that although there is very little difference between the amounts of nitrate formed from the cow-dung fermented aerobically or anaerobically, still there is a good deal of difference between the two lots of sheep-fold manure. This is illustrated in a separate chart (No. VI) comparing the two, from which it will be seen that the anaerobically fermented sheep-fold manure is inferior to the aerobically fermented one. As such difference is not noticeable in the case of cow-dung or urine when each of them is stored separately, but noticeable only in the case of sheep-fold manure, it is natural to enquire whether this inferiority with reference to nitrifiability of the anaerobically fermented sheep-fold manure is not due to the fact that it is a mixture of dung and urine; and whether separate storage of dung and urine of cattle would not be more advantageous than the addition of the urine into the manure pit? The question is well worth further study not only from the point of view of nitrifiability of material but also from another point of view, *viz.*, the loss of nitrogen during storage, as it was incidentally noticed that under anaerobic

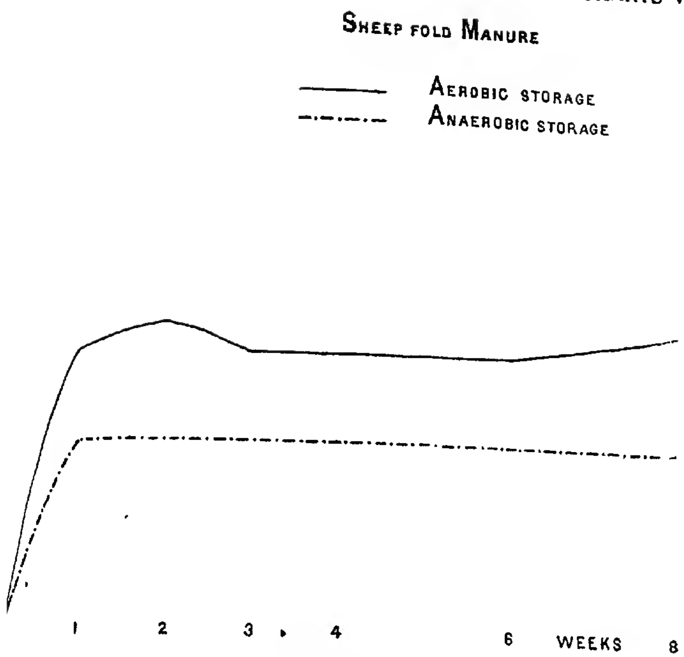
conditions of storage there was no loss of nitrogen from urine, that from cow-dung only slight, but sheep-fold manure under anaerobic conditions lost more nitrogen than either.

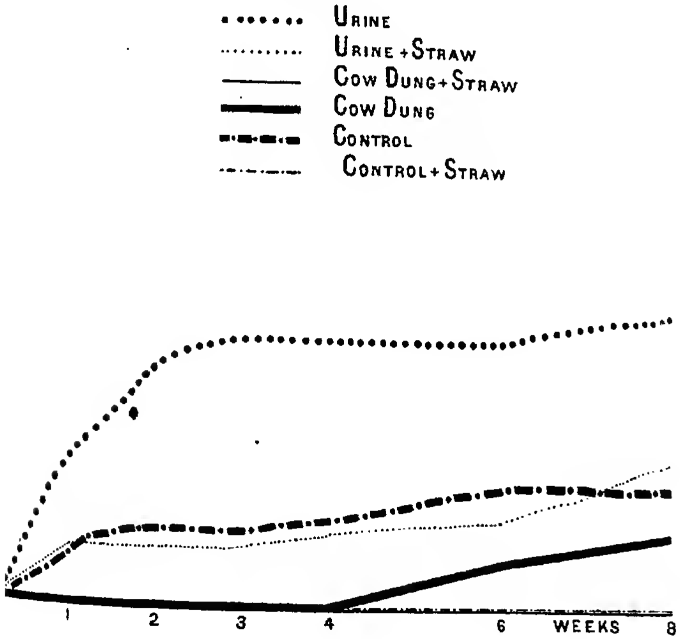
Under aerobic conditions there was loss in all cases, but as the figures for loss in moisture under these conditions were not accurately determined beforehand, no opinion can be expressed as to the relative loss of nitrogen from each of the materials. This question of loss of nitrogen during storage is being further investigated to obtain more accurate information.

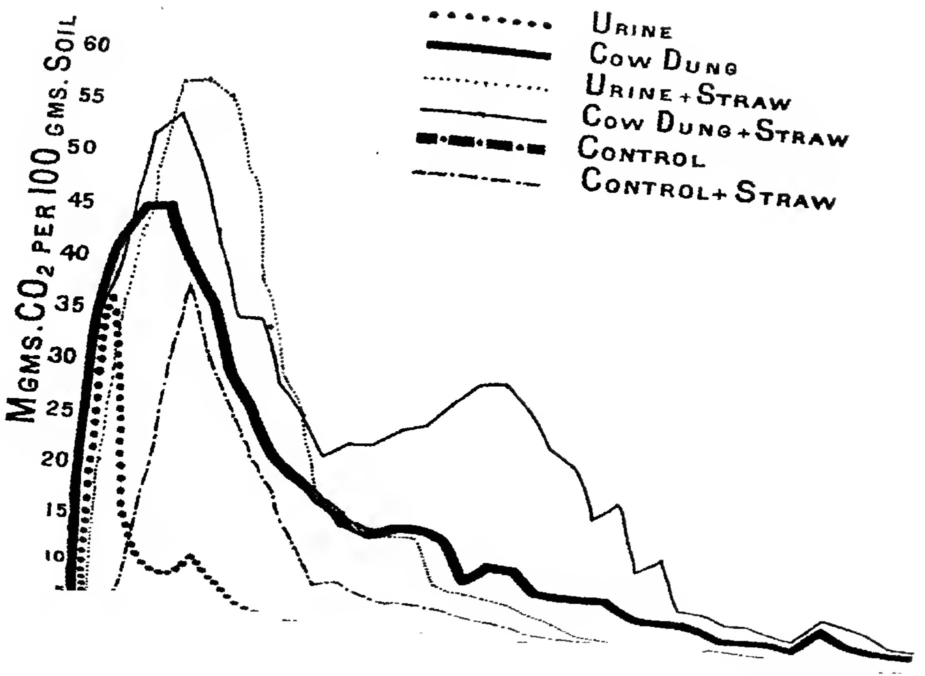
It must have occurred to many that the experiments carried out so far are open to one serious criticism, *viz.*, the excessive amounts of materials used in the experiments. These are no doubt higher than the amounts normally employed in the field. But these quantities were taken with due regard to the amount of nitrogen which had previously been found suitable for nitrification experiments with Pusa soil and to the fact that the concentration of nitrogen should be such as to enable one to detect even small differences in what may be termed the nitrifiability of materials. In order, however, to leave no room for criticism of such a kind, and also on account of the very wide differences in nitrifiability of materials compared (as already noticed in these trials), a fresh experiment was arranged in which the quantities employed approximated to what may be called heavy manuring such as is given to garden crops or other soil-exhausting crops like tobacco. The quantity of manure employed was calculated on the basis of 50 cart-loads, *i.e.*, about 25 tons of farmyard manure per acre. For ordinary crops 25 cart-loads are considered sufficient for Pusa soil. These quantities were found to supply 15 mgm. of N per 100 grm. of soil instead of 30 mgm. as before. The addition of straw was retained as a variation. Sheep-fold manure was not available at the time. Soil alone and soil plus straw were introduced as controls.

In addition to nitrification experiments, CO_2 production experiments were carried out. The CO_2 produced in soil by each of these treatments was measured every day in order to see whether there is any relation between the process of nitrification, as represented by

CHARTS VI & VII.







Mgms. CO_2 per 100 gms. Soil
60
55
50
45
40
35
30
25
20
15
10
Urine
Cow Dung
Urine + Straw
Cow Dung + Straw
Control
Control + Straw

CHART

the amount of nitrates which are the final product of the nitrogen changes, and the process of CO_2 production, which latter may be said to measure the general biological activity of the soil.

Furthermore, soils receiving the different treatments were plated out and bacterial counts made to see whether the number of bacteria and the amount of CO_2 produced could be correlated.

It was considered advisable to determine also the total nitrogen long with ammonia, nitrites, nitrates, etc. Besides, samples of soil were taken from each nitrification jar for determining the moisture content, loss on ignition and humus every week.

Charts VII, VIII and IX and Table I show the results which may, in general, be set down as follows.

The nitrate curves (Chart VII) fully confirm the results obtained in the previous two cases; fresh cow-dung shows practically no nitrate formation, while urine shows the highest. The addition of straw, as in the previous experiments, lowers the amount of nitrates.

The CO_2 production (Chart VIII) shows practically an inverse order as regards cow-dung and urine, cow-dung giving a much higher amount than urine. As regards the effect of addition of straw on CO_2 production, it may be observed that increased amounts of CO_2 are produced where straw is added as in the case of the control plus straw and urine plus straw as compared to the corresponding lots without straw. In the case of cow-dung, however, no such marked difference is observable, which may be explained by the fact that cow-dung itself contains a large quantity of undigested cellulose material; a further small addition in the shape of straw does not therefore affect the results to any great extent. The fact that nitrate curves and CO_2 curves are in the inverse order, and further that the addition of straw while lowering the amounts of nitrates leads to increased production of CO_2 needs to be emphasized. Previous writers have, on account of the similarity of curves for nitrate content and CO_2 production, tried to justify the view that the two processes are related to each other. It will appear as a result of our experiments, however, that these two processes are not necessarily correlated.

Chart IX illustrates the curves for bacterial numbers. A comparison of this chart with the previous one of CO_2 production shows a close similarity between the two sets of curves, which leads to the inference that the CO_2 production is directly related to the bacterial numbers.

Figures for total nitrogen are given in the accompanying table.

TABLE I.

Milligrams of total Nitrogen per 100 *grm. of soil.*

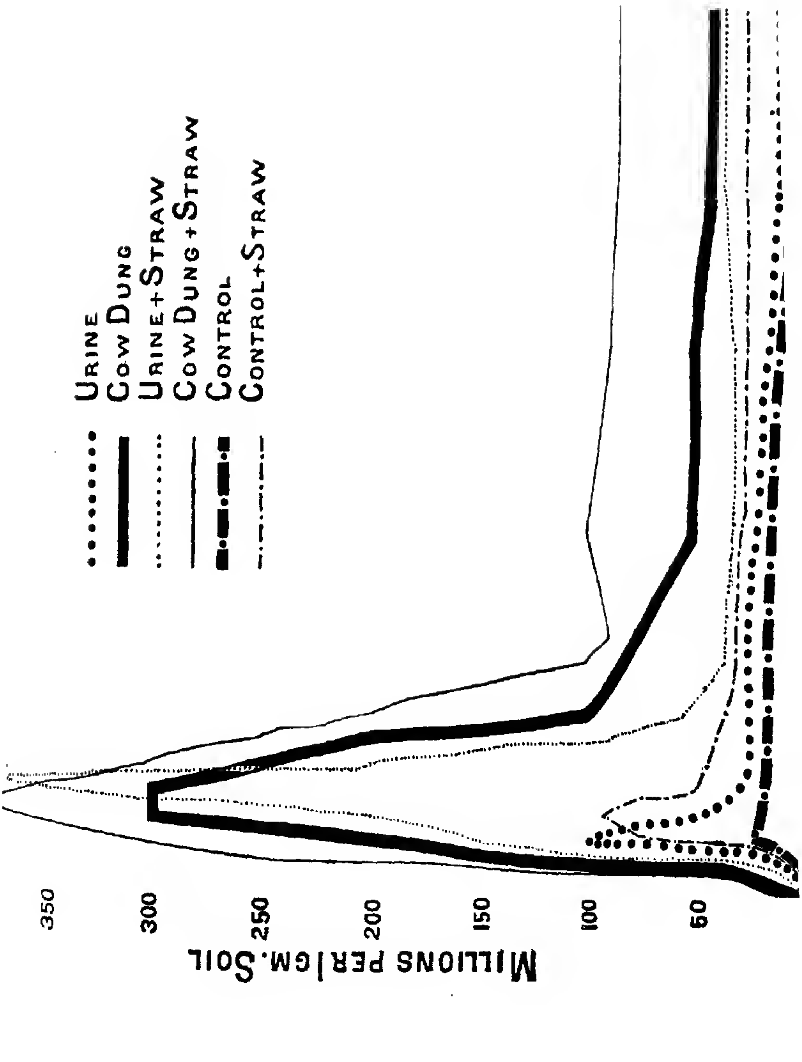
Treatment	Original	1st week	2nd week	4th week	6th week	8th week
Soil control ..	57·4	57·4	57·4	57·4	56·0	56·0
Soil+straw ..	60·2	60·2	60·2	60·2	61·6	61·6
Soil+cow-dung ..	75·2	79·8	79·8	81·2	81·2	81·2
Soil+cow-dung+straw	78·0	82·6	81·2	82·6	88·2	86·8
Soil+urine ..	72·4	70·0	70·0	68·6	72·8	71·4
Soil+urine+straw ..	75·2	79·8	79·8	79·8	82·6	79·8

It is interesting to note that the figures for total nitrogen determined weekly are higher in those cases where there is less nitrification (*e.g.*, in all those cases where straw has been added), and in order to account for this fact, it requires to be investigated whether there is any loss of nitrogen during nitrification or whether there is greater nitrogen fixation with the cellulose materials. A third alternative possibility, which has to be considered, is that the method for estimation of total nitrogen (which is meant and supposed to include nitrates) may be at fault. It is necessary, therefore, to examine critically whether any loss of nitrogen occurs during digestion, when nitrates in unusually greater quantities are present.

It may be mentioned that in the method used for determining the total nitrogen in the soil, copper sulphate was used instead of mercuric oxide, as this was recommended by Scott[1], and also because it was found that the use of the latter consistently gave lower

[1] Scott. *Standard Methods of Chemical Analysis.* Second Ed., p. 295.

CHART IX


URINE
COW DUNG
URINE+STRAW
COW DUNG+STRAW
CONTROL
CONTROL+STRAW
MILLIONS PER GM. SOIL
350
300
250
200
150
100
50

figures, whenever both the methods were compared, in the case of Pusa soil. Whether this result is due to impurities in mercuric oxide remains to be seen.

The only other feature of interest in the rest of the analytical results is that about 50 per cent. of the total humus is found to be free, the rest is combined with lime.

By way of anticipating criticism it might be observed that while the biological decomposition of organic matter is generally recognized to be of fundamental importance to soil fertility, it is nevertheless questioned by many whether a study, even under field conditions, of the processes leading to the decomposition of organic matter, and the assimilation of the resulting products by the plant, is of any real value. According to this line of argument, still less importance attaches to analytical figures obtained in the laboratory of nitrate nitrogen and CO_2 produced. In reply to this it must be said at once that laboratory results are not at all intended to be put forward as directly applicable to field conditions. There is an essential difference between laboratory and field observations, but each has got its own value. Whereas the field observations record the combined result of many factors, the effect of each of which it is not possible to distinguish in the field at once, the investigations in the laboratory give the results of each of the factors singly under rigidly controlled conditions, all factors except the one under investigation being kept constant. Attention might be called, for instance, to the observed differences in nitrification of the different tissues of green manures already described in a previous paper[1] and the differences in the decomposition of cow-dung and urine described in this paper. It would have been hardly possible to distinguish accurately between these differences in the field and, even if observed, most likely they would have been mixed up with some other factor like rainfall.

It may be further mentioned that the value of these laboratory observations on differences in nitrification, described in this paper, lies also in enabling us to distinguish between the separate effects

[1] Joshi, N. V. *Agri. Jourl. of India.* Special Indian Science Congress No., 1919, pp. 95-413.

of the two factors which are involved in manuring with organic nitrogenous fertilizers, *viz.*, the formation of nitrates, and the improvement in physical texture, each of which must affect to a certain extent the crop-producing power of the soil.

In order to discover how far the analytical results of nitrification tests are related to the crop-producing power, pot experiments with leguminous and non-leguminous crops are being carried out with dung and with urine added to the soil in the same proportion as that employed in the last experiments. These experiments are intended to elucidate how far crop production is influenced by variation in nitrification, and also to see what effect physical improvement alone, without any nitrates, has on the crop-producing power of a soil.

The results of the experiments detailed in this paper may now be summarized as follows:—

The opinion expressed in a previous paper that non-nitrogenous materials, like cellulose, lower the amounts of nitrates formed from the organic manures in which they are present in a fairly large proportion is confirmed by experiments with cow-dung, sheep-fold manure and urine.

Urine gives the greatest amount of nitrates, whether in fresh condition or when fermented under aerobic or anaerobic conditions, and so it can be used immediately or after keeping. Urine, if kept exposed to air, loses some of its nitrogen. It is therefore advisable to store it in such a way as not to be accessible to air.

Cow-dung does not nitrify in fresh condition. It, however, improves by storage and becomes nitrifiable after storage under both aerobic and anaerobic conditions. The relative losses under each of these conditions require to be more accurately determined before finally deciding which of these conditions is better so far as nitrifiability is concerned.

Results with sheep-dung indicate that mixture of dung and urine in the manure pit is not desirable from the point of view of nitrate formation, and also on account of the possibility of greater losses of nitrogen from such a mixture under partly anaerobic

conditions which are likely to prevail in the pit or even in a compact heap.

The two proccsses of nitrification and of CO_2 production, though sometimes found to correspond with each other, do not seem to be necessarily correlated. Nothing definite can be said as yet as to the relation of crop production to nitrification. It is hoped that the experiments now in progress will clear up this point.

COMPARISON OF SALT LANDS IN THE DECCAN AND IN SIND.*

BY

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Origin of salt lands in Sind and in the Deccan.

The origin of salt lands in Northern India, such as that in the alluvial tract of Sind, and in the South Deccan, which is a trap area, is widely different. In the one, the soils, which are transported, show in vertical sections that the layers of alluvial deposit often vary greatly. It is not unusual to find in such sections layers of pure sand alternating with those of pure clay. The layers themselves usually differ very much in their thickness. All this indicates that the nature of soils in such alluvial tracts can scarcely be uniform, with the result that the development of salts is also very irregular and even a small piece of land measuring a few *gunthas* (40 *gunthas* = one acre) is often seen studded with patches of alkali salts whereas the rest of the field has normally good land. In places like those of Sind where the rainfall is almost negligible and where the sub-soil water table is much more than ten feet below ground level, the development of salt is neither due to water-logging, nor due to the sub-soil water table being within the range of capillary power of the soils, which is generally found not to exert a pull of more than four feet on the sub-soil water.

Inundation flood, which is the chief source of irrigation at present in the northern parts of Sind, supplies water for cultivation

* Paper read at the Seventh Indian Science Congress, Nagpur, 1920.

during the months of June to September. After that severe extremes of weather follow. Excessive cold in winter and scorching heat in the hot season help a great deal in the disintegration of soil particles through which water moves in the downward direction during inundation season and in upward direction for the remaining eight months of the year. It is this downward and upward movement of water in the upper few feet of the soils which is responsible for the formation and deposition of salts in the alluvial tract of Sind.

In the Deccan the soils are mostly formed *in situ* by the disintegration of trap rock, and in vertical sections of soils all the stages of disintegration of the rock can be seen : such as the soil, *murum* or half disintegrated trap rock forming the sub-soil, and below it hard rock unaffected by the natural agencies of weathering. It is on this account that the soils in the Deccan are not so variable in their nature as the soils in Sind and the patchy nature of salt-affected land is not so common (though not altogether absent) as it is in the north of Sind.

The origin of salt lands in the Deccan is to be found in the general rise of sub-soil water table which has risen so high after the introduction of perennial canals as to be within five feet from the surface of the land and oftentimes even less than this. In such cases the sub-soil water constantly rises to the surface by capillarity, and evaporating there, leaves the dissolved salts behind. The lands in the Deccan are, moreover, not so level as those in Sind, so that the soils on lower level are more affected by seepage and water-logging than those on higher level.

NATURE OF ALKALI SALTS IN THE DECCAN AND IN SIND.

In the Deccan alkali salts are mostly formed by the disintegration and decomposition of trap rock, which is known to be one of the hardest of the common rocks. It is, however, found to yield comparatively easily to the natural agencies of weathering, being at one time covered under the water of the flowing river or canal, etc., and at other time being exposed to the heat of the sun. Probably the soluble salts in the river and canal water also help the

process of weathering. The trap rock being thus the origin of salts, it is interesting to know the nature of salts found to form from it during the process of decomposition.

The following table shows the nature of the river and canal water which always comes in direct contact with the trap rock :—

	Karha river water at Jejuri. Parts per 100,000	Nira Canal water at Pimpra. Parts per 100,000
Calcium carbonate	6·00	8·00
Magnesium carbonate	8·00	....
Sodium carbonate	5·00	1·00
Sodium bi-carbonate	4·00	....
Calcium sulphate	....	5·00
Magnesium sulphate	....	4·00
Sodium sulphate	4·00	....
Sodium and potassium chloride ..	13·00	6·00
	40·00	24·00

The trap rock, which under the influence of such water disintegrates and decomposes, was found to liberate the following salts in the proportion given below :—

	Slightly disintegrated trap rock	Much disintegrated trap rock
	%	%
Total soluble salts	1·13	1·15
COMPOSITION OF SALTS :—		
Calcium carbonate	18·50	2·60
Magnesium carbonate	....	1·30
Calcium sulphate	16·20	..
Magnesium sulphate	12·30	1·30
Sodium sulphate	28·50	12·50
Sodium chloride	23·90	82·50

This shows that sodium sulphate and sodium chloride predominate over all the other salts when trap rock is undergoing decomposition.

It is interesting to compare with these analyses the figures of analyses of salts found in the scrapings from barren salt land near Baramati in the Nira Valley :–

	Scraping I	Scraping II
	%	%
Total salts in dry soil	9·70	37·60
COMPOSITION OF SALTS :—		
Calcium carbonate	5·40	0·20
Calcium sulphate	3·40	0·40
Magnesium sulphate	2·30	0·30
Sodium sulphate	48·70	98·00
Sodium chloride	40·00	1·20

These figures also show the preponderance of sodium sulphate and sodium chloride in the composition of alkali salts found in barren salt lands of the valley.

The following are some of the typical analyses of soluble salts from particular spots which show the gradation from fertile to barren land commonly found near Malad in Baramati :–

	FERTILE SPOT		SPOT WITH POOR CROP		BARREN LAND	
	Surface–3″	3″–9″	Surface–3″	3″–9″	Surface–3″	3″–9″
	%	%	%	%	%	%
Total salts in dry soil	0·39	0·22	0·58	0·86	3·86	1·06
COMPOSITION OF SALTS :—						
Calcium carbonate ..	3·90	12·90	2·40	2·90	6·20	2·40
Magnesium carbonate	..	5·90	..	..	..	..
Sodium carbonate ..	4·40	8·60	1·60	7·00	2·60	1·10
Calcium sulphate ..	20·00	..	37·30	8·20	28·00	12·50
Magnesium sulphate.	9·10	4·20	26·50	..	..	8·90
Sodium sulphate ..	..	49·50	..	22·60	..	8·50
Calcium chloride ..	..	..	..	..	16·20	..
Magnesium chloride	..	..	7·80	..	13·40	..
Sodium chloride ..	62·20	19·90	21·20	59·40	41·90	66·50

In the majority of the alluvial tracts of Sind, the alkali salts are not naturally derived from any particular rock as the alluvium deposited there is of a varied character, being a mixture of

disintegrated particles of various rocks existing on the top of the Himalayas and down in the flats of the Punjab. There is therefore no particular rock whose decomposition products can be compared with those of the trap rock of the Deccan, the alkali salts in Sind being decomposition products of the alluvium itself.

The waters of the Indus and its canals which come in direct contact with the alluvial deposits gave the following analyses when the waters were collected during dry season :—

	Indus water near Sukkur	Water from the Hiral Canal
	Parts per 100,000.	
Total soluble salts	30·00	22·00
CONTAINING :—		
Calcium carbonate	5·01	6·24
Magnesium carbonate	....	....
Calcium sulphate	12·72	1·56
Magnesium sulphate	....	6·83
Calcium chloride	1·93	....
Magnesium chloride	6·86	3·25
Sodium chloride	1·16	1·78

The following are some of the typical analyses of alluvial deposits which are not yet injured by the accumulation of harmful salts :—

	Good land under cotton. Soil surface-6"	Good garden land. Soil surface-6"	Good land under wheat. Soil surface-6"
	%	%	%
Total soluble salts ..	0·13	0·21	0·30
CONTAINING :—			
Calcium carbonate ..	0·05	0·05	0·07
Sodium carbonate ..	..	0·02	0·02
Calcium sulphate ..	..	0·01	0·02
Magnesium sulphate ..	0·01	..	0·03
Calcium chloride ..	..	0·02	..
Magnesium chloride ..	0·05	0·04	0·01
Sodium chloride ..	..	..	0·06

Scrapings from barren lands of different types which could be clearly distinguished by the presence of white and black '*kalar*'* gave the following composition :—

	I. White *kalar* at Sarhari	II. Black *kalar* at Sukkur	III. Black *kalar* at Nawabshah
	%	%	%
Total salts in dry soil ..	24·60	20·24	7·80
COMPOSITION OF SALTS :—			
Calcium carbonate ..	0·13	0·19	0·39
Sodium carbonate ..	0·05	..	0·13
Calcium sulphate ..	5·73	14·15	9·78
Magnesium sulphate ..	1·13	..	..
Sodium sulphate ..	9·12	..	..
Calcium chloride ..	..	10·66	22·46
Magnesium chloride ..	..	14·21	21·14
Sodium chloride ..	83·84	60·79	46·10

It is clear from these figures that chlorides form more than 80 per cent. of the total salts of which sodium chloride is more than 45 per cent. Sulphates are present from 9 to 14 per cent. of the total salts, and in the white *kalar* sodium sulphate is present to the extent of 9 per cent. of the whole quantity of the salts. Sodium carbonate forms only a negligible quantity of the total salts which shows that the *kalar* of Sind is not of a very bad type.

A very remarkable thing that comes out of these analyses is the fact that sodium carbonate is not a necessary constituent of black *kalar*. It is usually supposed that sodium carbonate has a caustic action on the organic matter of the soil which gives a black appearance to the surface soil and hence the name black *kalar* to sodium carbonate, so that black *kalar* means sodium carbonate. From the above figures, however, it will be seen that No. II does not contain any sodium carbonate at all and No. III contains only a very small quantity, and yet the appearance of the surface soil at both these places is sufficiently dark to distinguish the spots as affected by black *kalar*. The only salts in No. II and No. III

* *Kalar, Lona, Usar, Reh* are synonymous terms used in different parts of India to mean salt efflorescence on the land.

to which the dark appearance of the soil may be due are calcium chloride and magnesium chloride. Of these, the former is known to have corrosive action on organic matter.[1] The black *kalar* on Sind soils, therefore, does not contain any appreciable quantity of sodium carbonate but contains a fairly large quantity of calcium chloride and magnesium chloride which are not injurious to plants like sodium carbonate or sodium sulphate.

On comparing the different types of *kalar* in Sind with those of *lona* in the Deccan it will be at once clear that the salt efflorescence in the Deccan contains comparatively a very large proportion of sodium sulphate, whereas in Sind sodium chloride predominates over all the other salts.

Resistance of crops towards salts.

In the Deccan the ordinary black soil does not usually contain more than 0·1 per cent. of soluble salts, but this does not necessarily mark the limit of salts up to which crops can be grown. Several crops have been found to resist the effect of salts much beyond this quantity, and the following are some of the analyses which indicate the limit of tolerance shown by some of the ordinary crops.

	Sugarcane. Soil surface–5″	*Chowli* (Vigna catjang). Soil surface–4″	*Wal* (Dolichos lablab). Soil surface–4″	Gram (Cicer arietinum). Soil surface–4″
	%	%	%	%
Total salts in dry soil ..	0·96	0·45	0·42	0·42
Composition of salts:—				
Calcium carbonate ..	6·80	12·62	4·76	5·24
Sodium carbonate ..	..	0·97	5·00	1·19
Calcium sulphate ..	43·00	33·00	3·33	30·70
Magnesium sulphate ..	1·00	28·65	9·53	15·24
Sodium sulphate ..	25·90	8·74	57·86	20·49
Sodium chloride ..	23·30	16·02	19·52	27·14

Of these crops sugarcane was growing excellently, being also supplied with heavy manuring. *Chowli* and *Wal* were doing fairly well and gram germinated well but failed later on.

[1] *U. S. A. Bureau of Soils Bulletin* No. 34.

Lakh (*Lathyrus sativus*) and Udid (*Phaseolus radiatus*) were similarly found to fail in a soil containing 0·48 per cent. of soluble salts of which sodium sulphate was about 66 per cent.

The following are a few of the analyses of Sind soils showing approximate limit of tolerance of some crops towards salts contained in the soil :—

	Rice. Soil surface—6"	*Lakh* (Lathyrus sativus). Soil surface—6"	Cotton. Soil surface—6"	Wheat. Soil surface—6"
	%	%	%	%
Total salts in dry soil ..	1·86	0·61	2·10	3·00
COMPOSITION OF SALTS :—				
Calcium carbonate ..	3·16	18·64	3·85	1·14
Calcium sulphate ..	8·87	16·94	51·92	22·05
Magnesium sulphate ..	14·55	27·51	10·26	..
Sodium sulphate ..	18·96	..	14·74	..
Calcium chloride ..	..	..	..	18·25
Magnesium chloride ..	..	20·34	..	16·35
Sodium chloride ..	54·43	16·94	19·23	42·21

The resistance of rice crop towards sodium chloride is well known from the fact that several rice varieties are grown on creek water in Konkan near Bombay.

In Sind, on Larkhana farm, saline water which could just maintain rice crop was found to contain the following amounts of salts :—

	Water confined in rice crop. Parts per 100,000
Total soluble salts	940·00
CONTAINING:—	
Calcium carbonate	5·17
Calcium sulphate	63·68
Magnesium sulphate	13·56
Sodium sulphate	38·34
Sodium chloride	742·50

The above is only an attempt to show approximately the limit of tolerance of several crops towards salt efflorescence in soils. Other factors such as frequent irrigation and consequent dilution during different stages of growth of the crops would materially modify the results.

BY

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Habit of plant an important character in all cultivated crops.

Habit of plant is a character of considerable importance in all cultivated crops. That each individual plant should be able to make full use of the air and light available to it without interfering with the growth of the neighbouring plants is a condition imposed by agriculture and the closer approximation of the individual plants which agriculture implies. Again, the habit of plant has often a direct bearing on the position of the produce at time of harvest. A cotton plant in which the lateral branches spread on the ground and bring the *kapas* in contact with the soil, dirtying it and thus depreciating its market value, and a paddy plant, which, by its spreading nature, allows its ripe earheads to trail on the ground, are obviously unsuitable for cultivation.

Particular importance of habit in sugarcane.

Habit is of special importance in the case of the cultivated sugarcanes. It is a long duration crop—occupies the land for 9 to 14 months in India, and even as much as 24 months in other countries like Hawaii—and if the neighbouring plants should show a tendency to get entangled with each other, the inter and after cultivation of the crop such as weeding, earthing and irrigation are rendered difficult. Secondly, it is accepted on all hands that

* Paper read at the Seventh Indian Science Congress, Nagpur, 1920.

a lodged cane rapidly degenerates in sucrose content. Dr. Leather, in *Agricultural Ledger*, 1896, says, "The juice of fallen canes was again separately examined, with the result that it was found to contain generally less proportion of cane sugar and a larger one of glucose than was found in the standing cane." Thirdly, a bad habit in the cane leads to the formation at the time of harvest of crooked and curved canes, which is a serious disadvantage from the factory point of view, as it seriously interferes with the compact packing of canes on the hopper. In sugarcane, the ideal would, therefore, be to aim at getting a variety which will consist of a series of parallel erect canes.

HABIT OF THE MAIN SHOOT DURING THE EARLY STAGES OF GROWTH.

During the early years of the Sugarcane Breeding Station, the depressed habit of the Madras seedling, M. 2, was studied by Dr. C. A. Barber, C.I.E., and Rao Sahib T. S. Venkatraman, and the results were presented in the form of a paper at the Madras Session of this Congress in the year 1915. It was there proved that the depressed habit in the particular Madras seedling was an inherent character resulting from geotropism. This year the study was extended to 20 varieties, chiefly the indigenous Indian canes belonging to the various groups classified by Dr. Barber in his Memoir, "Studies in Indian Sugarcanes, No. 3." Four buds were put down for each variety, but owing to casualties and other abnormalities in growth caused by shoot borers, etc., only 37 plants could be studied to the end of 87 days from planting, and the results are here given.

Statement showing the actual plants studied.

Group	Variety	No. of buds planted	No. of plants examined
THICK CANES ..	J. 247	4	4
NARGORI ..	Nargori	4	1
	Manga	4	3
	Katari	4	2
	Kewali	4	—
	Carried over	20	10

Group	Variety	No. of buds planted	No. of plants examined
	Brought forward ..	20	10
MUNGO ..	Kuswar	4	2
	Ramgol	4	—
	Matanwar	4	1
	Pararia	4	—
PANSAHI ..	Sanachi	4	4
	Kahu	4	2
	Lata	4	2
	Maneria	4	—
	Pansahi	4	—
SARETHA ..	Katha	4	3
	Lalri	4	1
	Kansar	4	3
	Dhaur Saretha	4	2
	Khari	4	3
	Hullu Kabbu	4	4
	TOTAL ..	80	37

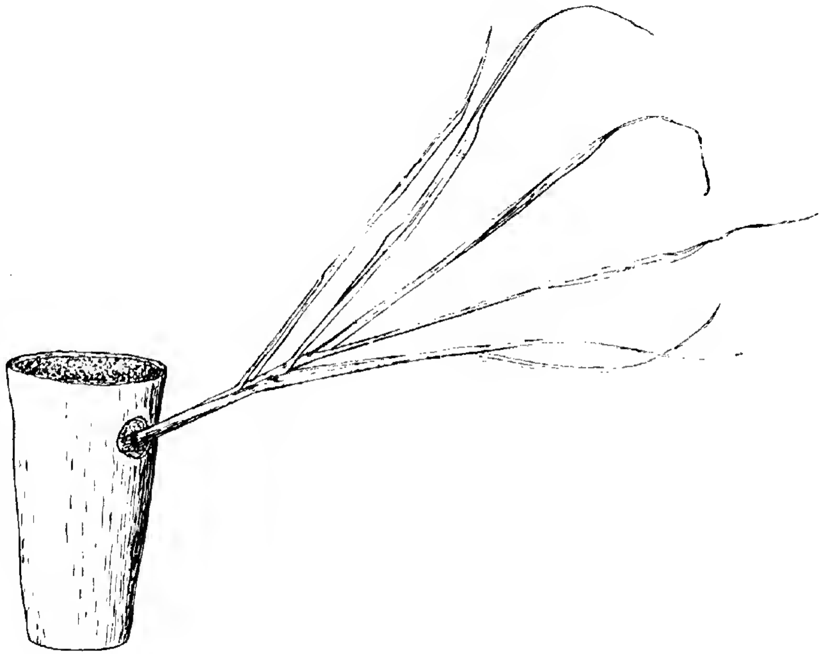
NOTE.—Sunnabile group was left out because of great variation in its components.

The main details of this paper are found in the Memoir " Studies in Indian Sugarcanes, No. 2," page 138.

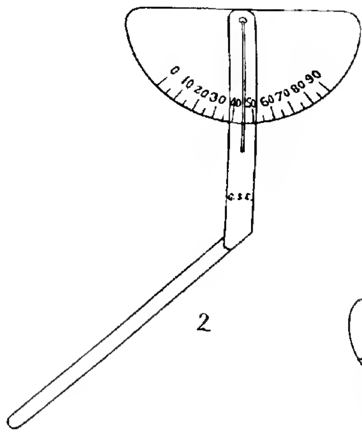
The buds were planted in tile pots with a lateral hole as seen in Plate XXII, fig. 1, and the angle of the main shoot was measured by means of an instrument (Plate XXII, figs. 2 and 3), being a copy of the one in use at the Paddy Breeding Station under the control of the Government Economic Botanist, Mr. F. R. Parnell. The observations were commenced on the 15th day from planting and continued to the 87th day, when it had to be discontinued, as it was felt that the tile pots were too small to keep the plants any further in a healthy condition. A more extended series, with the plants growing in big sized pots, is being laid to enable a continuation of this study up to the harvest of the canes. Each day two observations were recorded, one in the morning at 8 a.m., and another in the evening at 3 p.m., but as little difference was noticed between the two observations on the same day, only the morning observations were taken for study.

The curves in Chart I were plotted from the bi-weekly averages of the daily angles of the varieties in that group. Note the great

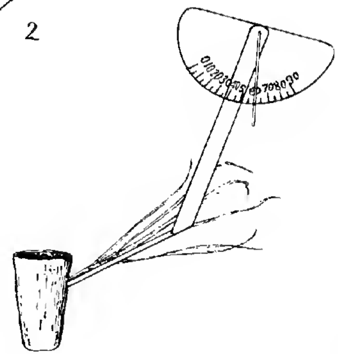
PLATE XXII.



1



2

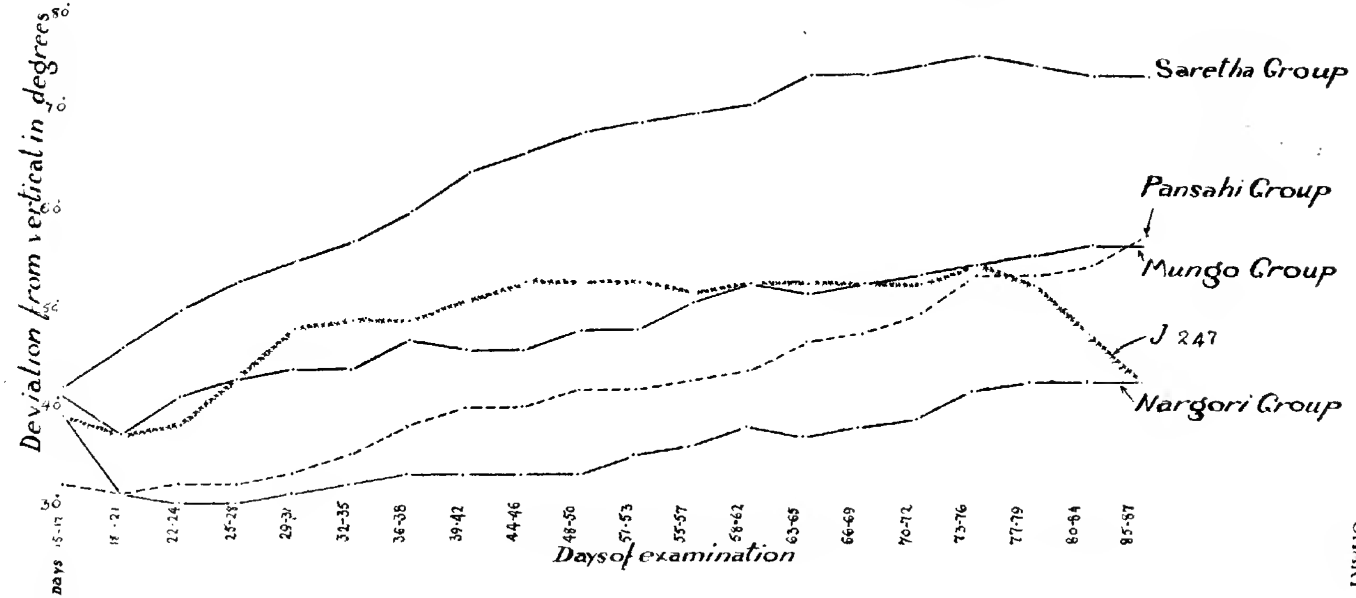


3

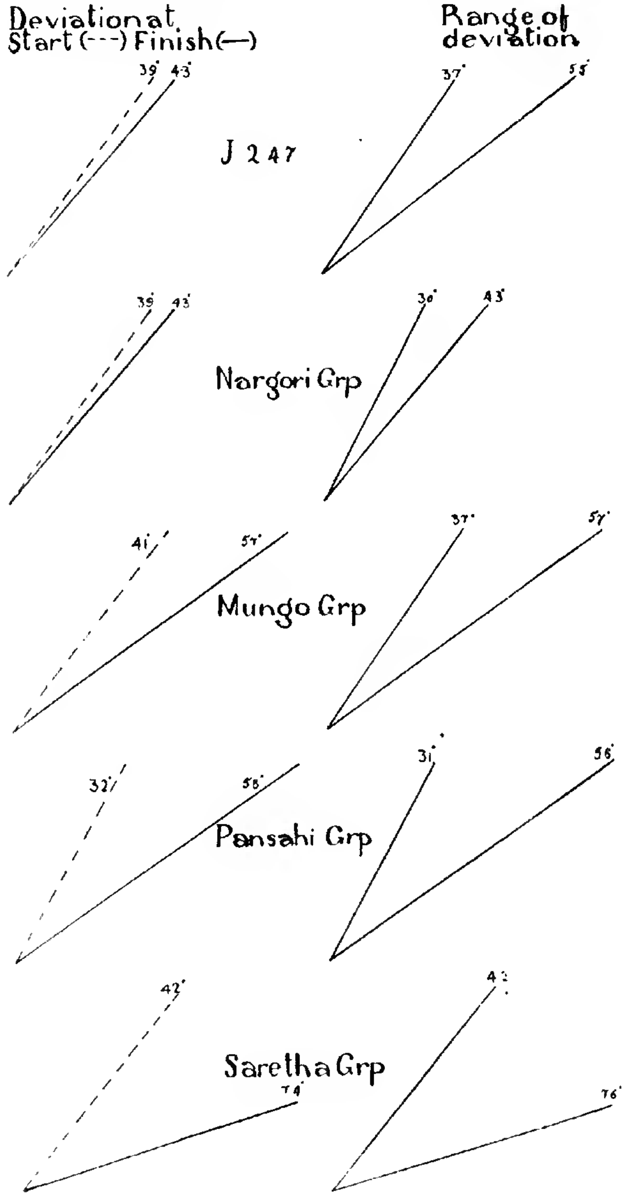
Sugarcane buds planted in a tile pot with a lateral hole   Nos. 2 and 3 show the instrument used for measuring the angle of the main shoot.

CHART I.

Curves showing the position of the main shoot with reference to the vertical from 15th to 87th day after planting



Showing deviation of the main shoot from vertical during the course of expt



dissimilarity between the curve for the Saretha group and those for the other groups which have a comparatively good habit at harvest.

Chart II shows the angles as noted at the start and at the end of the experiment for each group and the range of variation noted for the different groups during the course of the experiment.

It is interesting to note that, in Nargori group, which has probably the best habit of all the indigenous canes, the angle of deviation is the least, and Saretha group, the worst habited of the indigenous canes, shows not only the greatest range, but is distinctly worse than the others, both at the start and at the completion of the experiment.

STRAIGHTNESS OF CANES AT HARVEST IN THE DIFFERENT GROUPS OF INDIGENOUS CANES.

For some time the straightness of canes at the time of harvest has been recorded at the Sugarcane Breeding Station. Besides detailed notes on the relative straightness of early or late canes, 100 canes of each variety used to be laid on the ground and a general note recorded on the lot as a whole. Detailed notes are available, but they fall roughly into three classes. *viz.*. (1) straight, *i.e.*, with little or no curvature anywhere; (2) slightly curved, *i.e.*, showing a slight curving at the top or the base; and (3) curved.

The table on next page gives the number of varieties classed under the three heads during the years 1917 and 1919 when the crop was grown in the same field. In the year 1918 the canes were badly lodged and so the notes are not reliable.

Erectness of varieties at harvest.

Group	Year	STRAIGHT					SLIGHTLY CURVED						CURVED			
		Straight	Straight below and slight curved above	Total	%	% Average for 1917 and 1919	Straight below curved above	Slight curved	Slight curved below and curved above	Total	%	Average for 1917 and 1919	Curved	Total	%	% Average for 1917 and 1919
J. 247 ..	1917	1	..	1	100·0	100·0	..	..	..	..	..	..	..	..	..	..
	1919	1	..	1	100·0		..	..	..	..	..		..	..	..	
Nargori ..	1917	14	..	14	82·4	85·3	..	3	..	3	17·6	14·7	..	..	..	..
	1919	6	9	15	88·2		1	1	..	2	11·8		..	..	..	
Mungo ..	1917	32	..	32	97·0	94·4	..	1	..	1	3·0	5·6	..	..	..	..
	1919	30	3	33	91·7		..	3	..	3	8·3		..	..	..	
Pansahi ..	1917	10	1	11	73·3	63·0	4	..	..	4	26·7	37·0	..	..	..	..
	1919	7	3	10	52·7		5	4	..	9	47·3		..	..	..	
Saretha ..	1917	..	1	1	4·3	4·3	..	13	..	13	56·6	45·7	9	9	39·1	50·0
	1919	1	..	1	4·3		..	8	..	8	34·8		14	14	60·9	

Fig 1. Nargori group showing good habit.

Fig. 2 Mungo group showing good habit

Fig 1. Pansahi group showing very fair habit.

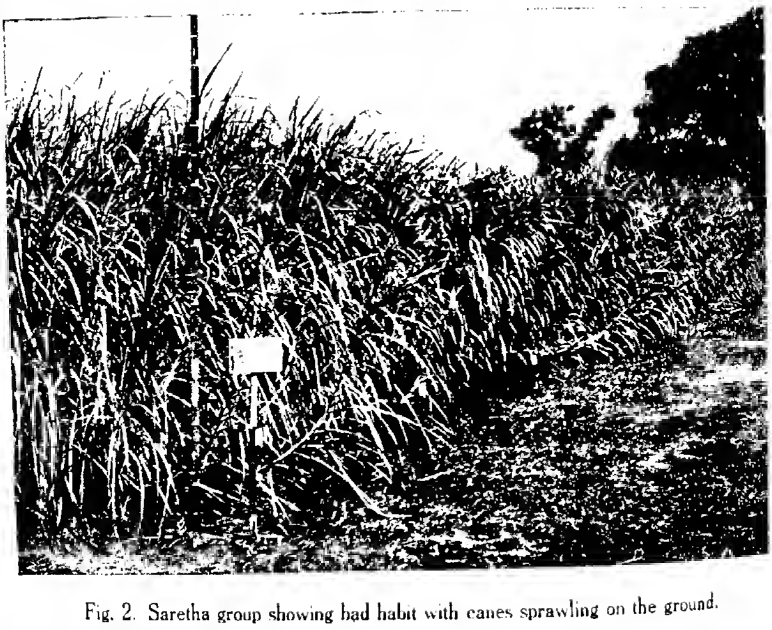


Fig. 2. Saretha group showing bad habit with canes sprawling on the ground.

J. 247, Nargori and Mungo groups which show comparatively little variation in angles in the growth of the main shoot show a large number of varieties with straight canes. Saretha group is the worst and Pansahi group occupies an intermediate position. (Plates XXIII and XXIV.)

THE INHERITANCE OF HABIT IN SUGARCANE SEEDLINGS AND ATTEMPTS TO IMPROVE IT BY CROSSING.

Bad habit, in a seedling bred for North India, was early realized to be a possible evil to combat with and, if possible, eliminate, and attempts were made even from the start to collect data to determine the mode of inheritance of this character among the seedlings raised from the same parentage. One of the most startling facts, brought out from the raising of canes from seed, is the great diversity that is noticeable in seedlings raised from one and the same parent, and this may be said to form the main basis on which the production of a seedling better than the parent depends.

But through all this diversity in the resultant offspring there is often traceable a certain amount of broad similarity among the seedlings of one and the same parent; and this similarity often expressed itself in the form of a similar habit among seedlings of the same parent.

From the tables below it is seen that whereas the seedlings of the Saretha group (Plate XXV) show a particularly bad habit similar to that of the parent, those of the Sunnabile group, for instance, show a better habit agreeably to the better habit of the parents.

Inheritance of bad habit in seedlings of Saretha group.

Year	Seedlings	No. planted	Good habit	Fair habit	Bad habit	REMARKS
			%	%	%	
1914-16 ..	Saretha G. C. ..	500	7·7	28·5	63·8	
	Do. Self ..	200	7·2	30·1	62·7	
1915-17 ..	Katha ,, ..	100	17·8	53·4	28·8	Rather ill-grown.
	Kansar ,, ..	100	16·9	40·5	42·6	Do.
	Lalri ,, ..	100	22·8	38·6	38·6	Do.
	Mesangen ,, ..	100	15·3	47·0	38·7	Do.
	Saretha ,, ..	100	4·5	58·4	37·1	Do.
1917-19 ..	Ramui G. C. ..	100	8·3	25·0	66·7	

Inheritance of good habit in seedlings of thick canes and Sunnabile group.

Year	Seedlings	No. planted	Good habit	Fair habit	Bad habit	REMARKS
			%	%	%	
1915-17 ..	Red ribbon G. C.	100	39·0	45·7	15·3	Parent has good habit and a thick cane.
	J. 247 ..	200	45·3	48·0	6·7	Do. do.
1917-19 ..	Putli Khajee ..	100	14·3	79·6	6·1	Parent habit fair, belongs to Sunnabile group.

It is however fortunate that by a suitable crossing it is found possible to influence the habit of the resultant seedlings. The table hereunder shows that the habit in seedlings is, to some extent, controllable by proper selection of the pollinating parent, though it should here be mentioned that the peculiarities of the sugarcane flowers makes it impossible to attempt this improvement of habit in all cases.

Influence of crossing on habit.

Year	Parentage	No. of seedlings planted	Good habit	Fair habit	Bad habit	REMARKS
			%	%	%	
1916-18..	Mauritius 1237 × M. 4694 ♂ ..	200	75·5	21·6	2·9	M. 4694 habit good
	Mauritius 1237 × M. 7319 ♂ ..	50	75·0	25·0	..	M. 7319 habit good.
	Mauritius 1237 × Saretha × S. Spt. ♂	150	39·0	51·7	9·3	Sar × Spt. bad habit.
1917-19..	J. 213 × Java ♂ (Hebbal) ..	140	1·1	75·3	23·6	Java fair habit.
	Do. × Purple Mauritius ♂ ..	100	0·0	70·6	29·4	P. Mauritius fair habit.
	Do. × Katha ♂	100	0·0	47·1	52·9	Katha bad habit.
	Do. × Kansar ♂	100	2·6	50·0	47·4	Kansar bad habit.
	Do. × Saretha ♂	100	0·0	40·7	59·3	Saretha bad habit.

Note.—Mother Mauritius 1237 has a good habit but it gave no selfed seedling because of infertility of its own pollen.

J. 213 has fair habit but it gave no selfed seedlings because of infertility of its own pollen.

My thanks are due to Rao Sahib T. S. Venkatraman, B.A., Acting Government Sugarcane Expert, for giving me all facilities and encouragement.

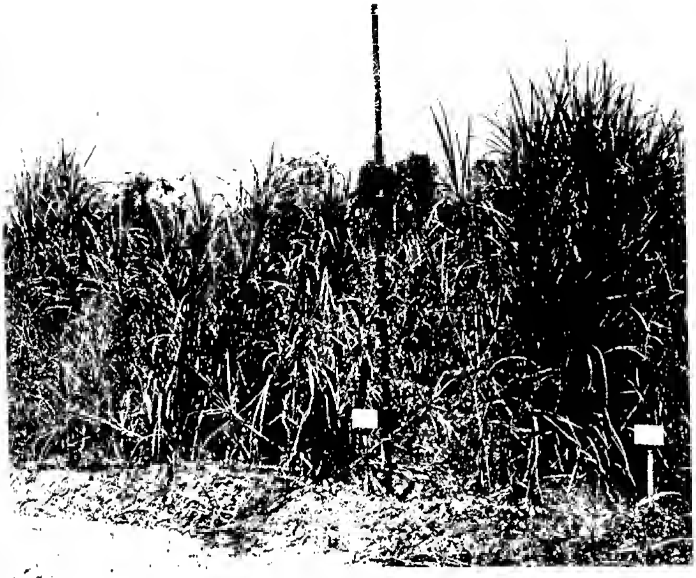


Fig 1. Katha and its seedlings. Note bad habit in both.

Fig. 2. Pansahi and its seedlings. Note the good habit.

Selected Articles

THE GROWTH OF THE SUGARCANE.*

BY

C. A. BARBER, C.I.E., Sc.D., F.L.S.

III.

THE presence of roots and shoots on the joints of the cane at crop time is, as we have seen, unwelcome. The new growths are of course useless for sugar making, and their presence in quantity lowers the purity of the juice at the mill. Besides this, all the joints in the neighbourhood of lateral shoots have a good deal of their stored sucrose changed into glucose, which is the form in which sugar travels to supply the material for fresh growing parts. We traced the formation of shoots and roots to climatic causes, chief among which was an excess of moisture, to lodging, to any check in the growth of the cane, whether by insect or fungus attack or accidental breakage, or, lastly, to the canes flowering some months before harvest time. We also noted that some varieties of cane are more prone to shooting than others. It is a very common phenomenon in diseased plants. In some cases the habit and general appearance of the bunch is entirely changed, and, in place of a few upright, clean canes, hundreds of small, grass-like shoots make their appearance (Fig. 1). This abnormality is apparently due to the most various causes. It is supposed to be induced by various insects and fungi, by eelworms in the roots, general malnutrition, and the presence of alkali in the soil; but it is often impossible

* Reprinted from the *International Sugar Journal*, December 1919.

to fix the responsibility on any one circumstance. It will be remembered that it is one of the features of the mysterious *sereh* disease which devastated the Java cane fields towards the end of the last century. The writer has met with a case in India where in a couple of acres, planted with cane for the first time, and in apparently ideal surroundings, after 14 months' growth only an

Fig. 1. A plant with many small shoots in place of a few healthy canes.

occasional isolated cane could be seen, and the whole field looked very much like one of *Guinea grass*. A thorough examination of

the tissues of the affected plants, both above and below ground, showed no sign of unhealthiness or any trace of insect, fungus or eelworm. The subject requires further study to determine the fundamental condition of the plant's economy which leads to this enormous development of shoots, which is in many respects similar to the "spike" disease of sandalwood.

But to resume our main study of sugarcane growth. To properly understand this under field conditions, it is necessary to examine the constitution of the bunch of canes derived from a single planted set, and this is especially the case when we come to consider the tillering power of different varieties. We have seen that the piece of cane planted has several joints, and that each of these joints has a bud which is capable of producing a complete plant. The bunch of canes in a single "hole" where one set has been planted may thus consist of one or more plants, according to the number of buds which "germinate." The number of separate plants in a bunch and their relative size and importance can only be determined by dissection. This is a tedious and difficult operation, for the lowest parts of the canes, where they are attached to their mother stems, are often thin and brittle. and furthermore, the whole underground part of the bunch is enveloped in an intricate weft of tough, fibrous roots, dead and living, which have to be cut away before the details of the branching can be laid bare. An example of such dissections is shown in Figs. 2, 3, and 4. In Fig. 2 a bunch of canes has been photographed as it was lifted out of the ground, with all the soil carefully picked and washed away, but the free spread of the roots is somewhat obscured by the pressure of the bunch upon them. Upon dissection, this bunch was proved to consist of four separate plants, which are shown in Figs. 3 and 4. In these four plants there were 7, 9, 4, and 8 canes, respectively, making a total of 28 for the whole bunch. The latter was only nine months old when taken out of the ground. but experience of many dissections has shown that no shoot not already forming cane at its base at that time can develop rapidly enough to be of use in the crop, and only such have been taken into account. The result, then, of planting a single set has been that four plants

were produced, with an average of seven canes each at harvest. The bunch was of the *Mungo* group of Indian canes.

Fig. 2. A bunch of *Mungo* canes arising from a single set. This is a dwarf variety with very short joints. The root system is poorly developed and not fully shown.

There are many lessons to be learnt by thus laying bare the whole branching system of a bunch of canes. It is easily seen that the individual canes are not of the same age. Some are formed very early in the life of the plant, while others have, so to speak, been produced at the last moment, and have barely time to complete their growth by harvest. Some of the main shoots are produced by the out-growth of the buds on the set, while others are branches of branches of these. As we know from our chemical analyses that the character and richness of the juice varies a good deal during the

life of each cane, gradually increasing until an optimum is reached and then declining, it becomes necessary to carry our examination further, and determine the whole scheme of branching. In the example given above, we must determine the relative stage of development of each of the 28 canes forming the bunch, and its correct position in the scheme of branching. Assuming, as a basis, that each shoot, if it develops unhindered, will produce one cane, we may divide them into classes on completing our dissection.

Fig. 3. The bunch in text-figure 1 dissected out to show that it consists of four separate plants arising from different buds on the set. In each plant the "mother" cane is indicated by a piece of white paper wrapped round it.

The shoot which is the direct outcome of a bud on the set is the main axis of the plant: this we term the "mother" cane and designate it by the letter *a*. Shoots formed from buds on the joints of *a* are branches of the first order, and we name them *b*1, *b*2, *b*3, etc., in the order of their arrangement from below upwards. Similarly, the branches on *b* are of the second order and marked *c* and so on with *d*, *e*, etc., as far as they appear. In the bunch of canes photographed, the four plants have the following constitution:—$a + 3b + 3c$, $a + 2b + 5c + d$, $a + 2b + c$, $a + 3b + 4c$.

Taking the whole of the canes of the bunch together, we have $4a + 10b + 13c + d$, and if we made enough dissections and calculated the resulting formulæ of the different plants, we could obtain an

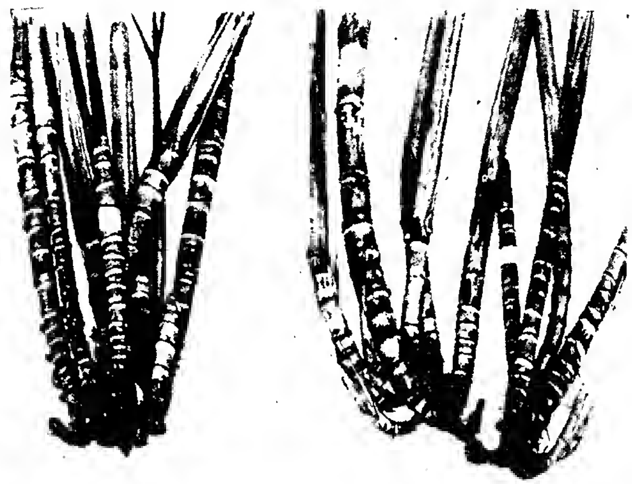


Fig. 4. The bunch in text-figure 1 dissected out to show that it consists of four separate plants arising from different buds on the set. In each plant the "mother" cane is indicated by a piece of white paper wrapped round it.

average constitution of a typical plant of the group. As a matter of fact, this has been done. Fifty-nine dissections were made of cane plants in the *Mungo* group, and the average formula for these 59 works out as $a + 2b + 2c + d$.

A study has recently been made of many other groups of canes[1] and the result of this shows that, while there are extreme variations in the formula of individual plants, the greater the number of dissections, the simpler the average formula becomes. In the following table some of the results of this study are summarized. In the first column the actual averages obtained in the dissections are recorded, in the second the theoretical formula of branching is put down, which, it is presumed, would be reached by the plants

[1] Barber, C. A. "Studies in Indian Canes, No. 4. Tillering or Underground Branching," *Memoirs of the Department of Agriculture in India, Botanical Series*, Vol. X, No. 2, June 1919.

if they had been grown in more ideal surroundings. It is obvious that, for this kind of study, all the varieties had to be grown under uniform conditions side by side in one place. And, as the place chosen was in many cases far removed from their natural habitat, climate, and soil, they did not grow as well as they were capable of doing. The dissections were made at the Coimbatore Cane-breeding Station in South India:—

Formulæ of branching of different groups of canes.

Group of canes	Number of plants dissected	Average of dissections						Theoretical formula					
		a	*b*	*c*	*d*	*e*	*f*	*a*	*b*	*c*	*d*	*e*	*f*
Wild grasses—*Saccharum arundinaceum*	5	1	4	6	6	5	0·4	1	4	6	6	4	1
Saccharum spontaneum	17	1	1	7	5	2	0·4	1	4	6	6	4	1
Indian canes—*Pansahi* group ..	29	1	3	4	2	..	..	1	3	4	3	1	..
Mungo " ..	59	1	2	2	1*	..	..	1	2	3	2	1	..
Saretha " ..	53	1	3	3	1	..	..	1	3	3	1	..	..
Nargori " ..	33	1	3	3	..	..	..	1	3	3	1	..	..
Sunnabile " ..	46	1	3	2	..	..	..	1	3	3	1	..	..
ck, tropical canes grown in India ..	41	1	2	1	..	..	..	1	2	1	..	..	..

*The formula for the *Mungo* group is reduced here because the varieties are dwarf canes with very short ; there are, therefore, more plants in a hole than in the other cases. As many as 7—11 plants were some- included in a bunch, and the branching of these was consequently small. By using another method the average obtained was 1, 3, 3, 2.

We learn from this piece of work that there is a good deal of difference in the branching powers of different groups of canes. The wild *Saccharums* head the list, and, as the cultivated canes (*Saccharum officinarum*) must have arisen from a wild ancestor, the former have been included. The branching of the wild *Saccharums* is the most prolific. The indigenous Indian canes come next, and can be roughly divided into two sets. *Pansahi* and *Mungo* branch a great deal, *Nargori* and *Sunnabile* much less wherever they are grown. *Saretha* in its native habitat (the Punjab and adjoining portions of the United Provinces, where tropical canes cannot, as a rule, mature) would belong rather to the *Pansahi-Mungo* set, although the dissections show a formula similar to that in *Nargori-Sunnabile*. Lastly, the thick, tropical canes branch least. It is a matter of common observation that their tillering

power is much less than that of Indian canes, and this is clearly brought out in the table. It should, however, be stated that the tropical canes grown on the farm were no more at home than the North Indian varieties. It would be difficult to find a place which suits both of these classes of cane plants. A set of 12 bunches of well-grown tropical canes was dissected on an estate in South Arcot, where they are grown successfully on a large scale for sugar manufacture. They belonged to the Red Mauritius variety, which is known as a free tillerer, and the object aimed at was to determine the possible branching of thick canes grown on an estate scale in India. The average of these 12 selected bunches gave the formula $1a + 3b + 3c + 1d$, and this may, perhaps, be a more general formula for canes grown in the various sugar growing countries in the tropics. It may be of interest, in conclusion, to point out that the Yuba cane of Natal, a member of the *Pansahi* group of Indian canes, was one of those included in the dissections. A good deal of attention is just now being paid to this hardy, primitive variety, and the extended formula of its branching system is undoubtedly one of its main attractions.

NOTE ON THE EXHAUSTION OF INDIAN SOILS AND THE METHODS BY WHICH THIS MAY BE REMEDIED.*

BY

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As a result partly of war conditions and of the shortage of grain stuffs resulting from the failure of the monsoon a year ago a good deal of attention has recently been paid to the present condition of Indian soils and the crop-yields obtained from these. The results of such investigations have tended on all sides to demonstrate that a very serious impoverishment of these soils is taking place and that energetic steps are necessary to remedy this state of affairs.

Let us consider for a moment the changes taking place in the soils. We know that the various plant foods, nitrogen, phosphates, potash, etc., may exist in the soil in a number of different forms. Some of these will be present as compounds which are of immediate use to the crop, others require to undergo various transformations before they can be taken up by the plant. The former class we describe as the "available" plant food, the latter as the "unavailable." The second term is of course a relative one, because, as I have explained, a certain proportion of the unavailable material slowly undergoes change and becomes available. Now how does this influence the crop? It is obvious of course that while there is a plentiful supply of available plant food the soil will be fertile and other conditions being favourable good crop-yields will be

*Paper read at the Madras Agricultural Conference, 1919. Reprinted from the *Journal of the Madras Agricultural Students' Union*, December 1919.

obtained. If this food supply however is not maintained by the addition of appropriate manures there will be a regular falling off in yield until eventually a state of balance is reached when the plant food removed in any given crop is equal to the amount of unavailable food rendered available during the time of growth. The yield obtained under such circumstances is of course very low and we refer to it as the "minimum cropping value of the soil." Owing to the relatively large reserves of plant food present in practically all soils, this low figure will remain practically unchanged for very prolonged periods. I have gone into these very elementary details of soil chemistry with which most of you are entirely familiar because it is sometimes argued that since many Indian soils go on producing year after year a fairly constant yield there is really little cause for anxiety. You will readily see that such an argument is fallacious. It simply means a very large proportion of these soils have already reached this minimum cropping value which I have just described, that is to say they are producing year after year crops far below those which could be raised after reasonable manurial treatment.

Now to meet the shortage of food stuffs to which I have already referred, there has been a vigorous demand in many quarters for the adoption of more intensive methods of cultivation and for the introduction of heavier yielding strains. Now both of these are eminently desirable things. but it is necessary we should realize one result of their adoption. It is perfectly obvious of course that the introduction of more prolific strains means we shall remove plant food from the soil at an increased rate. Similarly by more intensive measures of cultivation we shall increase the rate at which our reserve plant foods are brought into use and lead in this way to a more rapid depletion of our stocks. In other words. both these methods alone while giving us a momentary greater return will, unless accompanied by proper manurial treatment, eventually lead only to a still greater exhaustion of the soil and the final yield will again fall to the minimum value. The more intensive our methods therefore and the more prolific the strains we employ, the more imperative is the necessity for an extended and judicious use

of fertilizers. It is obvious that these fertilizers must be used in a systematic and rational method. If a soil is deficient in both nitrogen and phosphate such a soil will derive but little benefit from the application of nitrogen alone as the crop would still be limited by the phosphate deficiency. We may say then that usually general manures will be required, prolonged treatment with a manure containing one particular type of plant food only leading to a more rapid exhaustion of the other forms of plant food and hence ultimately to a reduction of fertility.

It is probably not generally realized to what extent soil exhaustion in India has already proceeded, so I may give one or two figures to illustrate the point.

In Madras we have during the last few years been engaged in a soil survey of the paddy lands of the Presidency and up to the present time have completed such a survey in four of the chief deltas, namely, Guntur, Tanjore, Kistna, and Godaveri. This survey has had as one of its principal objects merely to ascertain how far these soils are in need of immediate manurial treatment. The results are certainly instructive. Considering first the Godaveri Delta, which is generally considered to contain some of the most fertile land in the Presidency, we find nevertheless that 23 per cent. of the samples analysed show a deficiency in available phosphate and 40 per cent. or nearly half the delta a deficiency in nitrogen content.

The Kistna Delta gives slightly worse figures, 33 per cent. of the samples exhibiting phosphate starvation and 55 per cent. lack of nitrogen.

In the remaining two deltas the situation is even more serious, the figures being as follows:—

	Deficient in nitrogen	Deficient in phosphate
	Per cent.	Per cent.
Guntur	81	33
Tanjore	87	80

Comment on such figures is hardly necessary and there is no reason to believe that many of the other paddy lands of the

Presidency are in any better condition. If we remember that an increase of 5 per cent. only in the average yield would provide an extra 1,000,000 tons of rice a year in Madras alone, we can realize to some extent what the annual loss is in the whole country in this and other crops.

Examples such as the above could be brought forward in numbers. Clouston, in a paper read at the Indian Science Congress in 1918, stated that the four chief soils of the Central Provinces had in most districts reached a state of maximum impoverishment. In one of his experiments by an outlay of Rs. 33 per acre on manures in cane, the net profit per acre was increased by no less than Rs. 146, *i.e.*, over 400 per cent. the cost of the manure applied. In a similar way Davis has emphasized the critical condition of many of the Bihar soils as regards phosphoric acid content.

We may then, I think, take it as a fact that a very large number of Indian soils are already exhausted or approaching that state. We must pass on to consider what are the chief requirements of such soils and the reasons why under present conditions these requirements, urgent as they are, are being met to such a small extent.

In the examples I have quoted, we have seen that the deficiency chiefly consists of nitrogen and phosphates and this may on the whole be considered as applicable to the whole of India though certain districts—of which the Nilgiris and Malabar are examples,—are also extremely deficient in lime. Let us consider first of all the nitrogen question. Now nitrogen, like other plant foods, exists in the soil in available and non-available forms, the most available form, nitrates, being produced from complex nitrogenous compounds in the soil by a series of changes terminating in nitrification. Sometimes however these changes take another course and in this way an accumulation of relatively unavailable nitrogenous material may take place of which a familiar example is the production of peat. By cultivation we produce conditions, however, which are favourable to nitrification. One result therefore of the intensive cultivation to which I have already referred will be to accelerate this conversion of unavailable nitrogenous material into nitrates, and unless appropriate measures are taken, the reserves being

used up at a rapid rate, exhaustion will occur. Such cultivation moreover has another disadvantage. It is well known that under suitable conditions very large quantities of nitrogen can be added to the soil from the atmosphere by the agency of nitrogen-assimilating bacteria. But these bacteria require the presence in the soil of considerable amounts of carbonaceous organic matter. Hence if by our intense cultivation we use up at a rapid pace this organic matter in the soil we shall thereby at the same time diminish this valuable fixation of nitrogen.

It is obvious therefore that we must combine such methods of cultivation with liberal supply of manure, and for the reasons I have stated, bulky organic manures such as farmyard manure, *poonacs* and fish manure are peculiarly suitable to the conditions prevailing in this country. Such manures moreover have a further advantage as compared with more concentrated manures in that they improve to a marked degree the mechanical condition of the soil whereas the concentrated chemical manures have a tendency in the opposite direction.

It is particularly unfortunate therefore that the manures to which I have referred are precisely those which for various reasons are either being sent out of the country or else used in a wasteful manner. In the first place, the best use is not made of the manure most generally available, *viz.*, farmyard manure. In many districts this is used mainly as fuel resulting in a total loss of nitrogen. Even if this be not done the manure is almost invariably stored in such a way that at least 60 per cent. of the nitrogen is not utilized. Little effort is made to collect the liquid and more valuable portion of the manure or to protect the manure pit in any way, with the result that the aggregate loss in manurial value is enormous.

There is no doubt that many ryots at present do not realize the value of manures. This is a factor which time alone can remove but the ryot is a shrewd judge in many ways, and when once convinced by demonstration of the benefits to be derived he will not be slow to take up the use of manures. This has been shown in a striking way by the largely increased demand for fish guano even in districts remote from the source of supply. But assuming that

the ryot is fully convinced of the value of manure and anxious to obtain these, the price of most fertilizers has reached a figure which puts them quite out of reach of the small cultivator except in the case of the most profitable crops. The reason for this is the high price which manures such as oil-cakes and fish command in the foreign market resulting in a large export trade and a rise of price in this country.

Fish manure containing as it does a good percentage of both nitrogen and phosphate is particularly suitable to our soils and yet the export is increasing rapidly. In February of this year Colombo was paying Rs. 160 per ton for fish guano and consequently was attracting the bulk of this commodity which a year or so before was obtainable at Rs. 45 a ton ex-factory. This export is likely to continue, therefore, with a consequent increase in price in spite of the fact that the production of fish manure is necessarily limited and quite insufficient to meet the manurial requirements of the country.

When we come to consider the case of oil-cakes we find again exactly the same conditions prevailing. These cakes, though they contain sometimes a fair amount of phosphate, must be regarded chiefly as nitrogenous manure. Now the oil-seed crops are notoriously exhausting to the soil. But if the seeds were crushed and the resulting cake either applied to the land directly or in the form of cattle manure after feeding, there would at least be some return of plant food to the soil. But the tendency is all the other way. Not only has the export of oil-seeds steadily increased, but even in those cases where the seeds have been crushed in this country a large amount of cake is exported. The figures are instructive. Taking the normal years immediately preceding the war, the export figures for the whole of India were approximately as follows:—

		Tons	Value £
1913-14	ALL INDIA		
	Whole oil-seeds	1,572,792	17,000,000
	Oil-cakes	175,000	1,000,000
	FROM MADRAS ALONE.		
	Oil-seeds	....	3,500,000
	Oil-cakes	....	400,000
			(approximately).

This has naturally led to a great increase in cost and the state of affairs is likely to become worse owing to the intense demand for such products at the present time in European countries. Hence it is not surprising to find that the present price of groundnut cake is about Rs. 140 per ton or three times the price for which it could be obtained a very few years ago. It is impossible for the average ryot to pay such prices and it is in my opinion essential that steps should be taken to remedy this state of affairs. It would therefore appear necessary to prohibit entirely the export of fish manure of which the supply is so limited and to impose an export tax on oil-cakes in order to retain a large quantity of these in the country. With regard to whole oil-seeds also a heavy export tax should be imposed. In this way the oil-crushing industry could be developed in India, the oil being freely exported but the residual cake being consumed as far as required in this country. Two causes have hitherto tended to retard the development of oil-crushing in this country. The fact was that when oil-crushing was introduced, owing to the wholesale adulteration which took place Indian oils obtained a thoroughly bad reputation. Secondly, European countries have imposed an import duty on oil while allowing free entry to whole seeds and cake. The remedy for the first is obvious; in regard to the second, the conditions in Europe are such that it is doubtful whether these duties would be maintained if the supply of whole seed were restricted. Hence the times are now particularly favourable for such a change.

So far we have been considering nitrogenous manures. In the case of phosphates the situation is much the same. The chief phosphatic manures available in this country are bones, fish manure, and deposits of mineral phosphate. With fish we have already dealt. In the case of bones we again find a large export taking place. Owing to the war, the figures for the last few years have been erratic, but in normal times bones to the value of over 4 lakhs of rupees were annually exported from this Presidency alone chiefly to Ceylon. As a result of this external demand the price has steadily risen and early this year the excessively high figure of Rs. 130 per ton was being quoted in Ceylon for bone meal. This is therefore another

case where export should be totally prohibited. The bones retained in this way could readily be crushed at a large number of centres because many land owners are already in possession of oil engines which are not fully employed and which could therefore be used with advantage to drive small disintegrators. In this way bone meal, which has given good results in this country, would be available at a greatly reduced cost.

In the case of mineral phosphate deposits in this country we are at present in some doubt as to the best method of utilization. They are not suitable for the preparation of superphosphate and when used alone the availability is of a very low order. A considerable number of experiments have been carried out here to increase their availability by using the crushed mineral phosphate in combination with organic matter. The experiments have been sufficiently successful to indicate that a satisfactory method of utilizing these deposits will probably be found, but it cannot be said that the correct conditions have yet been realized.

Quite recently claims have been put forward regarding a phosphatic manure termed "tetra phosphate" which is prepared in a very simple way from rock phosphate. These experiments have been carried out chiefly in Italy and in my opinion the evidence is not particularly convincing. In view of the importance of utilizing our supply of phosphate we are, however, at present carrying out trials to test this new method on the Trichinopoly deposits, but the experiments are not yet sufficiently advanced to indicate the probable result.

One other possibility has lately arisen in connection with such deposits. Very favourable results have been obtained in America by the use of ammonium phosphate. Such a fertilizer, containing as it does about 13 per cent. of ammonia and 40 per cent. of soluble phosphate, would probably be particularly suitable for the conditions prevailing in South Indian soils. The possibility of utilizing the Trichinopoly deposits in such a way depends entirely on the cost of production and this will again depend largely on the production of cheap ammonia which is quite a feasible proposal in this country. At any rate the prospect opens out a promising field of enquiry.

While dealing with future possibilities I may also refer to the use of what is known as "activated sludge," which is the final deposit obtained in the most recent method of sewage disposal. The substance when dry contains about 6-7 per cent. of nitrogen instead of the 1-2 per cent. in the older product and may eventually therefore form a valuable manure in the neighbourhood of large towns where such a system will sooner or later will have to be adopted.

We dealt so far with the indigenous manures of the country and we must finally consider how far we can make use of synthetic methods for utilizing the nitrogen of the atmosphere to make nitrogenous fertilizers. There are three or four ways in which this is now being done in other countries. First, there is the Arc method in which by means of a powerful electric arc the oxygen and nitrogen of the atmosphere are made to combine to form nitric acid. This requires very high powers and large production to be profitable and will not, I think, be practically suitable for Indian conditions. Secondly, we have the Haber process for synthetic ammonia by which hydrogen under the influence of a catalyst is made to combine with atmospheric nitrogen to form ammonia which can then either be converted into ammonia sulphate or further oxidized to nitric acid. This is one of the cheapest ways of producing ammonia and enormous quantities of ammonium sulphate are now being manufactured in this way so that there is a considerable likelihood of a considerable fall in price as regards this fertilizer. This probability is increased by the report recently published of an important improvement on this process which will considerably reduce the cost of production. The process, however, requires skilful supervision and will not therefore be particularly easy to establish in this country. Lastly, there is the cyanamide process in which atmospheric nitrogen is passed over heated calcium carbide with the formation of calcium cyanamide, a valuable nitrogenous fertilizer, which is also easily capable of conversion into ammonia. The requisite materials for this process are supplies of limestone, fairly pure charcoal and reasonably cheap electric power and it is likely to be the best adapted for use in this country.

There is no doubt ample scope and opportunities for the development of such industries in India. Not only are the fertilizers produced of the greatest value in themselves but they could be used in combination with *poonacs* of poor quality such as *pinnai* or *dupake* cake which at present can be profitably used alone.

It may be remarked in passing that a new nitrogenous fertilizer has recently received much attention, *viz.*, ammonium nitrate, which was largely used in the war as a constituent of explosives. The advantage of this compound is that it contains nearly 35 per cent. of nitrogen and so is the most concentrated nitrogenous manure made, a factor of value where transport has to be considered.

I hope I have now been able to show that it is possible by the methods indicated, *viz.*, restriction of export of *poonacs*, uncrushed oil-seeds, bones and fish manures and by the development of the processes for the synthetic production of nitrogenous manures, to reduce very considerably the price of manures in this country. I have only time to refer very briefly to the other measures necessary to ensure the best use of the materials thus made available. The first necessity is the further education of the ryot. As I indicated, this is not so difficult as sometimes supposed and machinery already exists for such work and only requires expansion.

Secondly, the cost of transport must be reduced to a lower figure. Hence co-operative purchasing is indicated in order that manures may as far as possible be carried in bulk with consequent reduction in freightage rates. For similar reasons purchase in bulk is necessary in order to obtain favourable terms, and this means credit must be provided. There is therefore a large field here for the development of co-operation.

Finally, there is the difficulty, and it is no small one, of the present system of land tenure in many parts of the country. So insecure is the position of the tenant that he cannot reasonably be expected to sink capital in improvements from which he himself may obtain but little benefit and for which, if evicted, he can claim no compensation.

The whole question therefore is by no means a simple one but the time is quickly approaching when it will have to be faced in a

reasonable manner. The population is increasing rapidly and I believe that the enhanced production required can only be brought about by a determined effort to increase the *permanent* fertility of the soil by reasonable manurial treatment. At present there is a tendency to face it in another way by the attempt to bring into cultivation large areas of more or less unprofitable land, but judged only from the point of view of production this can have but little permanent value and cannot be regarded as anything but a palliative of a temporary nature.

SUMMARY.

The situation may then be summed up briefly as follows:—

1. A large proportion of the soils of the country are already suffering from starvation or are approaching that state.

2. The supply of indigenous manurial products is being sent out of the country at an increasing rate with the result that the price is now prohibitive to the small cultivator.

3. Such a deficiency must be met by (*a*) limitation of export of such materials; (*b*) increased production of synthetic nitrogenous manures, in which methods based on the cyanamide process would appear to be most likely of success in this country; (*c*) development of processes for the utilization of the phosphatic deposits of the country.

4. In order to utilize the increased supply of manurial substances, attention must be directed to (*a*) education of the ryot to realize their value; (*b*) development of co-operative buying and transport; (*c*) revision of land tenures where these do not give the tenant a sufficient margin of protection.

THE POSSIBILITIES OF CITRUS CULTURE IN INDIA.*

BY

A. H. WITTLE,

Of "Orchard Dene," Yercaud.

MUCH interest has been awakened in recent years in the cultivation of fruit and the production of articles of consumption previously imported. There is no doubt that, if the subject was better understood and the knowledge properly applied, the greater proportion of the money paid to outside producers might be kept in the country, not only to the material economic advantage of India, but also from a health point of view.

India—and I may even confine my statement to apply to the Madras Presidency—with its varying altitudes and climate is, in my opinion, as near as possible, ideal for the cultivation of almost every known variety of fruit, and what with the ever improving economic position of the majority of Indians, combined with Government assistance in opening up an experimental jam and preserve factory on the Nilgiris, there is, and always will be, a growing demand for really well-grown fruit.

At the present time, demand is undoubtedly outpacing the supply.

Apart from the urgent need for fresh fruit, there is also a growing demand for preserves, cool drinks, etc., such as marmalade, candied-citrus peel, raw and sweet lime juice, citric acid, crystals for mineral waters, and citrate of lime which is used in its crude form for bleaching certain kinds of linen. Also other bye-products,

* Paper read at the Madras Agricultural Conference, 1919. Reprinted from the *Journal of the Madras Agricultural Students' Union*, December 1919.

which, owing to simple methods of manufacture, could easily be made in this country by any intelligent ryot, after receiving a few lessons from an expert of the Agricultural Department, and it is my good fortune to know how keen the officials of the Agricultural Department are, in every branch, to help one and to give valuable advice merely for the asking.

What with cheap labour, combined with a few simple and effective appliances for cultivation, and given facilities for irrigation where necessary, and average good land—such as is met with more or less all over the country—with an addition of fertilizers intelligently applied, we should not only be capable of producing enough first class fruit for our own requirements, but could compete most favourably with other exporting countries on the European markets.

The most suitable places in South India for citrus culture would be parts of the Nilgiris, Shevaroys, Kunnamalais and many other hills, the Malabar Coast, Wynaad and, in fact, almost anywhere where there is good soil and ample rainfall, say, from 60 to 120 inches average, or where irrigation is available.

Citrus fruits do best in a deep, loamy soil rich in humus and the essential plant foods, but it has been my experience that almost any soil can be made to grow good, healthy fruit trees; with proper preparation of the soil before planting and what with cheap labour and suitable implements, which are available in the country at present, it is not a very difficult or expensive matter to bring some of the most intractable and apparently indifferent looking soil into a fit state to grow excellent fruit trees. It is merely a matter of thoroughly working, and in some cases, sub-soiling, draining, and ploughing in one or two green manure crops and adding suitable fertilizers, and the trees—other things being equal—will not only grow well, but very soon bear paying crops.

Now to the question of the right kind of plants to propagate or purchase :—Cheap trees, merely because they are cheap, usually prove to be the most expensive in the long run; therefore, purchase your trees from a reliable nurseryman and pay him a fair price for the very best trees he can produce. You may be told that two

or three year old plants, such as one sees in nurserymen's show gardens, and which are usually covered more or less with fungi of sorts, trying to grow in a 6-inch flower-pot, will make excellent growth when planted out, and will bear fruit in one or two years. These plants are sold at a low price and are usually not worth paying freight on. It is more economical to pay a good price for really well-grown healthy plants free from leaf and other diseases and also guaranteed true to name and thus avoid the possible dissemination of virulent plant diseases. It is to be hoped, now that the Pest Act is in force, Government will consider the necessity of inspecting plants offered for sale in every nursery in the country, and no one should be allowed to sell plants to the public without first obtaining an annual certificate of cleanliness from an authorized Government expert. I know a case where a man spent a considerable amount of money on citrus plants which were covered with a most destructive fungus disease and, had it not been that he procured advice, and had not the plants been properly treated in time, he would have lost the whole of them and, worse still, would have given up in despair an enterprise which has since proved a most remunerative undertaking, thinking that either the climate or soil was unsuitable.

As regards suitable varieties, there are many, and, on looking through a catalogue, one is often bewildered by the host of varieties named, all—or nearly all—of which appear to have special merits. As India is the home of citrus tribe, it would be as well to consider the best of those usually grown in the locality, such as the Nagpur *santara* orange, the Sylhet, and in South India, especially in Coorg, that which has come to be known locally as the Coorg orange, are perhaps three of the best. Of imported varieties, there are Washington Navel, Navelensia, Mediterranean Sweet, Paper rind, St. Michael Joppa, and Valencia late—to mention only a few of the best; there is Sevill orange (*C. vulgeris*) and sometimes called *C. bigardia* or bitter orange, which is used extensively in the manufacture of marmalade and also for the extraction of essential oil from the rind, leaves and flowers, which is used as a base in the manufacture of some of the most expensive perfumes and also for

the manufacture of citrate of lime from the juice. A sample taken from this variety growing locally was found to contain 9 oz. of citric acid crystals per gallon of juice.

The citron (*C. medica* sp.), the rind of which is used in the manufacture of the candied peel of commerce, and for which there is a large demand. Juice of this fruit also has been tested and found to contain over $7\frac{1}{2}$ oz. of citric acid per gallon of juice.

The Pomelo (*C. decumana*), which is sometimes called the Shaddock, grape fruit, etc. Apparently there are three varieties of this fruit grown in South India, although none of them could by any stretch of imagination be considered to resemble a grape in taste. There is no doubt, however, that there is more than one variety of this fruit which is really delicious when prepared by extracting the bitter membrane and sprinkling the pulp with sugar. I have it on the authority of an expert in such matters that it is a delicious and refreshing fruit to eat early in the morning. There is no doubt that if this fruit with its vigour, deep-rooting system, and enormous bearing qualities was extensively grown and the taste for it acquired, there would be an enormous demand at remunerative prices, and it probably would become as well known and appreciated in India as it is in Europe and America at the present time.

The lime (*C. medica* var. *acida*) of which there are at least three distinct kinds, *viz.*, thorny, thornless, and seedless. If possible, the thornless variety should be chosen for general cultivation owing to the convenient way in which pruning, gathering the fruit, and general cultivation can be carried out, and this applies especially in India, where the labourers generally work bare-footed. If, however, a thorny variety be planted, the inconvenience of the thorns can, to a great extent, be overcome by careful handling at pruning time, by having some kind of cart, handled between the lines in which all prunings are thrown, and this will probably pay for doing, in view of the fact that, so far as is known at present, the thorny gives the highest percentage of citric acid. There does not appear to be any appreciable difference between the thorny and seedless varieties in this respect.

It is found, where limes are grown on a large scale, that the citric acid content of the juice varies considerably with the rainfall, that is, in a wet climate or season the acid content is low, whereas during dry weather, or where the average rainfall is small, the acid content is high, the variation being from 10 oz. per gallon in the wet weather to 14 oz. in dry weather—tests in the West Indies. In June of this year, after trees growing in Yercaud had passed through a very severe dry weather, the juice tested as high as 21½ oz. per gallon, whereas in December, after a long spell of wet weather, the test gave only 10 oz. to the gallon. At the same time, the variation in such figures may be more apparent than real, as fruit may contain more juice in a wet season than in a dry one, and it is quite possible that, although the percentage of citric acid per gallon may be lower in wet weather, the probable extra amount of juice will compensate, or perhaps more than compensate, for the higher percentage in dry weather fruit. Although the different kinds of lime in general cultivation do not appear to vary greatly either in acid content or the amount of juice per given weight of fruit, this is a point which appears to lend itself to very useful research work, both on the line of natural selection, and possibly through budding selected plants on to vigorous stocks, with a view to improve not only the yield of acid content, but also the improvement in quality and quantity of the essential oil in the rind, and this is a point well worth considering before planting out on a large scale, the main issues being the citric acid percentage, quantity of juice and essential oil obtainable per acre. And I cannot find that, up to the present, this subject has seriously been studied in a scientific manner. It is obvious that one acre of limes giving an average of, say, 2,000 fruits per tree of 10 oz. acid content is more profitable than one giving 200 per tree of the same sized fruit giving 10 oz. acid per gallon.

You will now naturally want to know the possible returns from citrus fruit growing, and this is a point on which I fear much controversy will arise, and to avoid the possibility of misunderstanding which may lead a prospective planter astray and cause him to invest his capital without a full knowledge of the subject,

I will say at once that other things being equal—much, in fact everything, depends on the individual. At the same time, there is no reason why any one interested in fruit culture should go astray when really sound advice can be easily obtained from the Agricultural Department, and—strange as it may seem—I have much more faith in the eagle eye of an entomologist or mycologist than in a painted *chatti* which one sometimes sees erected on a pole to ward off the evil eye. As there is now no excuse for any one going astray on this point, I will give you some figures which may encourage some one to have a flutter at what I consider to be a paying proposition. To begin on the safe side, I cannot, I think, do better than quote figures which I gave to a fruit-planter who obtained my advice some time ago in connection with his orange trees, which consisted chiefly of Mandarines, Washington Navel, Navelia, St. Michael, Mediterranean Sweet, and Lemons; these figures refer to 9-year old trees which were allowed to overbear in the fourth year and suffered, not only in consequence of this but also from neglect of the ordinary practices of cultivation for the remaining five years and they were in anything but good condition. I estimated that given proper cultivation and pruning, each tree should give an average of 5 dozen perfect fruits the same season, which, considering the excellent varieties and the advantageous market conditions, would have sold at 8 annas per dozen or Rs. 2-8-0 per tree, and this on over 700 trees, or roughly 7 acres, or say, Rs. 250 an acre. Allowing Rs. 100 an acre for cultivation, manure, etc., and cost of marketing the crop, it would have left Rs. 150 an acre clear. Had those trees been properly cared for and Rs. 100 an acre spent annually on cultivation, pruning and manure, they would have, at 9-year old, given considerably over 500 fruits per tree, and this is what I consider to be a fair average crop on well-cared-for trees under general Indian conditions for oranges, lemons, citrons, etc. Limes of course bear much heavier crops, and, owing to their being planted 15′ × 15′ apart which would allow them ample room even on the best of soils and give 193 trees per acre, I have seen trees which gave an annual crop of between three and five thousand limes of good size. As to the prices obtainable for fruit in different

districts, much depends on the market facilities on each plantation; it is impossible to give anything like an accurate statement as to possible profits in each district. But the figures I have given will, I think, enable any one interested in the subject to form a fair idea on this point. Unfortunately I am unable to go into details of the manufacture and sale prices, etc., of citric acid in such a short paper as this must be. There are other aspects of citrus culture, such as the preservation of fruit by the sweating process and allied subjects, which, I fear, must be left out of this paper, also through lack of time. As it is, I am afraid I have overstepped the time limit and trust you will excuse the prolonged babbling of an enthusiast.

BRITISH CROP PRODUCTION.*

BY

DR. EDWARD J. RUSSELL, F.R.S.

CROP PRODUCTION in Britain is carried on in the hope of gain, and thus differs fundamentally from gardening, which is commonly practised without regard to profit and loss accounts. Many poets from times of old down to our own days have sung of the pleasures to be derived from gardening. But only once in the history of literature have the pleasures of farming been sung, and that was nearly two thousand years ago.

> Ah! too fortunate the husbandmen, did they but know it, on whom, far from the clash of arms, earth their most just mistress lavishes from the soil a plenteous subsistence.—"Georgics," Bk. II., l. 458 *et seq.*

"Did they but know it"! Even then there seem to have been worries!

This seeking for profit imposes an important condition on British agriculture: maximum production must be secured at the minimum of cost. This condition is best fulfilled by utilizing to the full all the natural advantages and obviating so far as possible all the natural disadvantages of the farm—in other words, by growing crops specially adapted to the local conditions, and avoiding any not particularly well suited to them.

From the scientific point of view the problem thus becomes a study in adaptation, and we shall find a considerable interplay of factors, inasmuch as both natural conditions and crop can be somewhat altered so as the better to suit each other.

It is not my province to discuss the methods by which plant-breeders alter plants; it is sufficient to know that this can be done

* Discourse delivered at the Royal Institution in February 1920. Reprinted from *Nature*, dated the 8th April, 1920.

within limits which no one would yet attempt to define. The natural conditions are determined broadly by climate and by soil. The climate may be regarded as uncontrollable. "What can't be cured must be endured." The scheme of crop production must, therefore, be adapted to the climate, and especially to the rainfall.

The rainfall map shows that the eastern half of England is, on the whole, drier than the western half. In agricultural experience, wheat flourishes best in dry conditions and grass in wet conditions; the vegetation maps show that wheat tends to be grown in the eastern and grass in the western part. The strict relationship is that seed production is appropriate to the drier, and leaf production to the wetter, districts.

The great soil belts of England south of the Trent run in a south-westerly direction; north of the Trent, however, they run north and south. A heavy soil, like a wet climate, favours grass production; a light soil, like a dry climate, is suitable for arable crops. The great influence of climate is modified, but not overridden, by the soil factor.

The arable farmer grows three kinds of crops: corn, clover or seeds hay, and fodder crops for his animals or potatoes for human beings. The same general principles underlie all, and as corn crops are of the most general interest (though not necessarily of the greatest importance) they will serve to illustrate all the points it is necessary to bring out. We have seen that wheat is cultivated more in the eastern than in the western portion of the country. The figures for consumption and production are as follows:—

Millions of tons per annum.

	Consumption in United Kingdom	Production in England and Wales			Production in United Kingdom		
		Before war 1914	1918	1919	Before war 1914	1918	1919
Wheat ..	7·40	1·6	2·3	1·8	1·7	2·6	2·0
Barley ..	1·96	1·2	1·2	1·1	1·6	1·5	1·3
Oats ..	4·30	1·4	2·0	1·6	3·0	4·5	4·2

During the war very serious attention was paid to the problem of reducing the gap between consumption and production. A working solution was found by lowering the milling standard, retaining more of the offal, and introducing other cereals and potatoes; a very considerable proportion of the resulting bread was thus produced at home. But the war-bread did not commend itself, and disappeared soon after the armistice; since then the consumption of wheat has gone up, and the divergence between consumption and production has again become marked. There is no hope of reducing consumption; we must, therefore, increase production. Additional production may be obtained in two ways: by increasing the yield per acre, and by increasing the number of acres devoted to the crop.

The yield per acre is shown in the following table:—

Measured bushels per acre.

	(1908-17) Average yield per acre		A good farmer expects	Highest recorded yield
	England and Wales	Scotland		
Wheat ..	31·0	39·9	40 to 50	96
Barley ..	31·9	35·4	40 to 60	80
Oats ..	39·3	38·9	60 to 80	121

Unfortunately the terms "bushel" and "quarter" (8 bushels) lack definiteness, being used officially in three different senses and unofficially in several others also. The following are some of the definitions of a bushel:—

	Official statistics. A definite volume having the following average weight	Corn Returns Act. Volume occupied by following weight	Grain Prices Order. Volume occupied by following weight	Frequent practice. Volume occupied by following weight
	lb.	lb.	lb.	lb.
Wheat ..	61·9	60	63	63
Barley ..	53·7	50	55	56
Oats ..	39·3	39	42	42

The average results include bad farmers and bad seasons; the good farmer expects to do considerably better, but he has many things in his favour: superior knowledge, greater command of capital, and possession of good land; he will, therefore, always stand above the average. Even his results can be improved; the highest recorded yields show what can be done with present varieties and present methods in exceptionally favourable circumstances. The figures give the measure of the scientific problem, which is to discover what changes would be necessary in order to bridge the enormous gap between the average and the best. In three directions progress is possible: we may modify the plant, or the soil, or we may mitigate the effects of unfavourable climate.

Before the soil can be brought into cultivation at all it is necessary to carry out certain major operations—draining, enclosing, etc., —which have to be maintained in full order. These lie outside our present discussion; we must assume that they are properly carried out, which is by no means always the case. Given adequate drainage, soil conditions are profoundly modified by cultivation, which has developed into a fine art in England and Scotland, and is, indeed, far better practised here than in most other countries. But it is an art, and not yet a science; the husbandman achieves the results, but no one can yet state in exact terms precisely what has happened. A beginning has been made, and a laboratory for the study of soil physics has been instituted at Rothamsted and placed under Mr. B. A. Keen, where we hope gradually to develop a science of cultivation. For the present cultivation remains an art, and, further, it is essentially a modern art. The medieval implements, as shown in the Tiberius MS. (eleventh century) and the Luttrell Psalter (fourteenth century), were crude, and left the ground in an exceedingly rough condition. Great advances were made throughout the nineteenth century. Robert Ransome, of Ipswich, took out his first patent in 1785 to improve the plough; he was followed in 1812 by Howard, of Bedford, and later by Crosskill, Marshall, Rushton, Fowler, and others, who have made British implement makers famous throughout the world. Given time and sufficient labour

the good British farmer using modern implements can accomplish wonders in the way of cultivation.

Unfortunately, neither time nor labour is always available. Ploughing is possible only under certain weather conditions, and there are many days in our winters when it cannot be carried out. Unless, therefore, a large staff of men and horses is kept, the work often cannot be done in time to allow of sowing under the best conditions.

The early days of the life of a plant play almost as important a part in its subsequent history as they do in the case of a child. Illustrations are only too numerous of the adverse effect of being just too late for good soil conditions. One from our own fields is as follows :—

Work completed	Seed sown	Yield of wheat 1916 Bushels per acre
Just in time	Nov. 24, 1915	26·8
Just too late	Feb. 17, 1916	19·3

The farm-horse will not be speeded up, but maintains an even pace of 2½ miles per hour. According to the old ploughman's song still surviving in our villages, an acre a day is the proper rate :—

> We've all ploughed an acre, I'll swear and I'll vow,
> For we're all jolly fellows that follow the plough.

But under modern conditions it is impossible to get more than three-quarters of an acre a day ploughed on heavy land, and the scarcity of teams threatened to bring arable husbandry into a hopeless *impasse*. Fortunately for agriculture, the internal-combustion engine appeared on the farm at a critical moment in the shape of the tractor, and has brought the promise of a way out. The tractor has two important advantages over the horse. First of all, it works more quickly. Its pace is 3½ miles per hour instead of 2½ miles. It turns three furrows at a time instead of one only ; on our land it ploughs an acre in four hours instead of taking nearly a day and a half as required by horses. There is no limit to the work it can do ; even an acre an hour is no wild dream,

but may yet be accomplished. It therefore enables the farmer to get well forward with his ploughing during the fine weather in late summer and early autumn, and thus to obtain the great advantages of a partial fallow and of freedom to sow at any desired time. On our own land our experience has been as follows:—

Dates of completion of sowings of wheat and oats.

Year	Wheat	Oats	
1916	February 17 ..	October 16 ..	Horses only.
1917	March 16 ..	„ 17 ..	Horses only.
1918	January 26 ..	„ 27 ..	Horses only.
1919	November 26 ..	„ 5 ..	Tractor.

Further, if the plough is correctly designed and properly used, the tractor does the work fully as well as horses—even the horse-ploughman admits that. It therefore increases considerably the efficiency of the labourer, which, as we shall see later on, might advantageously be raised. The cost of working is apparently less, though it is difficult to decide this until one knows what the repairs bill will be. In our case the cost is:—

Cost of ploughing per acre, Autumn, 1919.

	By tractor	By horses
	s. d.	s. d.
Labour	7 7	10 2
Maintenance	—	22 6
Oil and petrol	7 8	—
Depreciation and repairs	6 3	—
	21 6	32 8
Time taken ..	4 hours	1½ days

The internal-combustion engine is only just at the beginning of its career on the farm, and no one can yet foresee its developments. It is being used at present simply like a horse, and is attached to implements evolved to suit the horse. But it is not a

horse; its proper purpose is to cause rotation while it is being used to pull, and in some cases, indeed, this pull is reconverted into rotary motion.

The second great method of improving soil conditions is to add manures and fertilizers. Farmyard manure is more effective than any other single substance; it is likely to remain the most important manure, and if available in sufficient quantity it would generally meet the case. Realizing its importance, Lord Elveden generously provided funds for extended investigations at Rothamsted into the conditions to be observed in making and storing it. This work is still going on, and is leading to some highly important developments.

Farmyard manure, however, is not available in sufficient quantities to meet all requirements. The chemist has long since come to the aid of the farmer; he has discovered the precise substances needed for the nutrition of the plant, and prepared them on a large scale. Like cultivation, this is largely a British development; it was in London that the first artificial manure factory was established in 1842, and for many years the industry was centred in this country. The fertilizers now available are as follows:—

Nitrogenous. Nitrate of soda, nitrate of lime, sulphate of ammonia, and cyanamide (nitrolim).

Phosphatic. Superphosphate, basic slag, mineral phosphate, guano, and bones.

Potassic. Sulphate of potash, muriate of potash and kainit.

Agricultural chemists have worked out the proper combinations for particular crops, and obtained many striking results.

Without using any farmyard manure they have maintained, and even increased, the yield of corn crops, fodder crops, and hay; and in the two latter cases there has been an increase, not only in yield, but also in feeding value per ton. In spite of seventy years' experience there is still much to be learned about the proper use of artificial fertilizers, and they may still bring about even fuller yields from the land.

The yield of corn crops can be increased by artificial fertilizers, but not indefinitely; the limit is set by the strength of the straw.

As the plant becomes bigger and bigger, so the strain on the straw increases, until finally when the plant is some 5 ft. high, it cannot stand up against the wind, but is blown down.

Little is known about the strength of straw. It is a property inherent in the plant itself, and differs in the different varieties. It is affected by the season, being greater in some years than in others. It is affected also by soil conditions. At present the strength of the straw is the wall against which the agricultural improver is pulled up. The problem can undoubtedly be solved, and the plant-breeder and soil-investigator between them may reasonably hope to find the solution.

Another great effect of artificial fertilizers which has not yet been fully exploited is to mitigate the ill-effects of adverse climatic conditions. Phosphates help to counteract the harmful influence of cold, wet weather; potassic fertilizers help the plant in dry conditions. The combination of a suitable variety with an appropriate scheme of manuring is capable of bringing about considerable improvement in crop production.

A demonstration with the oat crop on these lines was arranged last year in a wet moorland district and the crops when seen in August were as follows:

	Estimated crop Bushels	
Local variety, local treatment	27	Harvest late.
Local variety, phosphatic manuring	45–54	" earlier.
Special variety "Yielder," phosphatic manuring ..	54–66	" earlier. stands up well.

The potato crop is governed by the same general principles as corn crops. It furnishes more food per acre than any other crop, but it is much more expensive to produce, and therefore is grown chiefly in districts where the conditions are particularly well suited to it: the Fens, Lincolnshire, the plains of Lancashire, and the Lothians, though smaller quantities are grown in almost every

part of the country. The production and consumption are as follows :—

Potatoes : Annual production and consumption.

Consumption	Production					
	In England and Wales			In United Kingdom		
	Pre-war			Pre-war		
6·5 millions of acres	1914	1918	1919	1914	1918	1919
	3·00	4·20	2·70	7·50	9·29	6·30
	0·46	0·63	0·48	1·20	1·51	1·22

We are thus self-supporting in the matter of potatoes. We do, however, import about half a million tons per annum of early and other potatoes ; we also export seed potatoes and some for food—in all, about one million tons per annum.

(*To be continued.*)

Notes

CONTRIBUTIONS FOR AGRICULTURAL INVESTIGATIONS.

THE Trustees of the Sir Sassoon David Trust Fund have made the following grants to the Bombay Department of Agriculture :—

1. A contribution of Rs. 6,666 per annum for three years for the investigation of the insect diseases of *jowar* (*Andropogon Sorghum*) and their methods of control.

2. A contribution of Rs. 5,000 per annum for three years for the investigation of methods of improving poor grazing lands under Deccan conditions.

3. A contribution of Rs. 5,000 per annum for three years for the investigation of the eradication of the most serious weeds of cultivation, and especially of *lavala* (*Cyperus rotundus*).

4. A contribution of Rs. 6,666 per annum for three years for the investigation of drought-resisting, high-yielding varieties of food crops, and especially of *bajri* (*Pennisetum typhoideum*).

5. A contribution of Rs. 2,000 per annum for three years for the study of the deterioration of cardamoms in the spice gardens of Kanara.

6. A contribution of Rs. 3,333 per annum for three years for the study of the economic efficiency of agricultural implements in Western India, and its increase.

7. A contribution of Rs. 5,000 for the investigation of the difficulties of potato cultivation in the Deccan.

8. A contribution of Rs. 10,000 towards the cost of buildings for the rice experimental station at Karjat (Kolaba District, Bombay Presidency).

THE ORIENTATION OF THE BANANA INFLORESCENCE.

There has always been a vague belief among banana growers that the orientation of the banana inflorescence is a thing that can be controlled. It was thought that the said inflorescence would appear either on the side of the plant where the cut surface of the corm is found or on the exactly opposite side. No scientific evidence for the belief existed.

The evidence given below tends to show that the inflorescence appears on the side opposite to the cut surface of the corm from which it springs.

In July 1919 the writer superintended the planting of an area of bananas in the Ganeshkhind Botanical Garden. This area measures $1\frac{1}{2}$ acres and contains 550 plants mainly of *Sonkel* and *Rajapuri* varieties. All corms were planted in the same way, namely, with the cut side facing north. It was hoped thus to protect the bunches from the southern sun, if the bunches came out on the north side.

After three or four months all trees showed a slight inclination to the southern side. In the beginning of March 1920 many of the trees of the *Rajapuri* variety began to bear. In every case so far the inflorescence is toward the south.

The inclination of the trees toward the south gave the writer an idea and he hastened to test it by digging out the soil and exposing the roots of a couple of trees. In both the trees examined it was found that the cut surface of the corm had produced no roots, but that the roots were produced along the border of the cut surface. Roots are, however, produced freely from the rest of the corm. This absence of roots from a great portion of one side of the corm means less firm anchoring on that side. As the tree sways with the wind it is conceivable that there is a gradual tendency to bend away from the weakly anchored side. The banana inflorescence, when it appears, will, by the force of gravity, bend over to that side towards which the stem is already leaning.

The number of trees now bearing is 64, and all the inflorescences are bent towards the south. If all the others bend in the

same manner it would seem that there is some ground for the writer's theory, namely, that the bending away from the side of the cut is simply due to imperfect anchoring in the soil.

It is of course possible that this bending, all in one direction, may be due to some factor in the environment. This doubt can be removed by planting the corms so that each row has the cut surface opposite that of the next row. This would bring the inflorescences facing one another in every two rows if the writer's theory is true.

If the theory proves to be true, advantage can be taken of it to plant corms so that the inflorescence and the fruits will not suffer from the sun, or to plant them so that the bunches face one another between the rows and so can be easily watched.—[P. G. DANI.]

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A NOTE ON *HELIOTHIS (CHLORIDEA) OBSOLETA*, Fb., AS A PEST OF COTTON.

DURING the course of investigation into the bionomics and incidence of *Pectinophora gossypiella* now being carried on at Coimbatore we were surprised to discover *Heliothis obsoleta*, Fb., was engaged in committing more havoc than *Earias fabia*, *Earias insulana* and *Pectinophora gossypiella* put together. As far as the writer is aware this is the first record of *Heliothis obsoleta* appearing on cotton in pest conditions. In America and in Africa it is a regular pest of cotton, but so far does not appear to have damaged this crop in India.

At the time when most damage was being done, and the damage was considerable, not only was there about 15 acres of Bengal gram (*Cicer arietinum*) on the farm, but next to one of the attacked fields were some tobacco plants in seed. These latter were not touched. The gram crop was almost a total loss. Cambodia cotton appeared to suffer rather more than *Uppam* or *Kurangunni* although the latter varieties were in the next field to the gram field.

The *Heliothis obsoleta* larvæ feed on the young green bolls of the Cambodia both from the outside, according to their usual habit when attacking gram, and also at times entered entirely into

the boll and stayed there until they had eaten the entire contents. At other times a U-shaped tunnel would be driven through the boll. In other cases again the outer rind would be nibbled and then left. In nearly every case where the boll had been entered, a boll attacked meant a boll destroyed, unlike *P. gossypiella* which does not always damage the whole boll. It was observed that before beginning to attack a boll, *H. obsoleta* larvæ would often spin a few threads of silk between the boll and the bracts. At first these threads were attributed to spiders until the time when larvæ were seen at work spinning them.

There is no doubt that if this change of habit (as far as India is concerned) on the part of *H. obsoleta* were persisted in, it would be a far more dangerous pest than either *Earias* or *Pectinophora*.

The attack was first noticed early in January and by the end of February all larvæ had disappeared. A table is given below showing the amount of damage done. This table does not take into account the bolls and buds attacked and fallen to the ground as no trace of these could be kept. The bolls examined did not come from one field but from several fields at different places on the Central Farm.

It may be noted that one consignment of green bolls from Pollachi, distant some 30 miles from Coimbatore, also showed that *H. obsoleta* was present in pest conditions.

No. of bolls examined	Date	Percentage damaged			Remarks
		P.	E.	H.	
* 2,000 ..	10-1-20	45·5	2·50	6·50	6·5% of the bolls destroyed.
2,000 ..	17-1-20	1·1	?	1·80	Increase of flowers and buds.
2,000 ..	24-1-20	0·5	0·65	1·10	
2,000 ..	31-1-20	0·3	0·45	3·75	
2,000 ..	7-2-20	0·4	0·40	3·20	
1,000 ..	14-2-20	0·6	0·60	3·00	
1,000 ..	21-2-20	1·0	2·10	0·50	
1,000 ..	28-2-20	1·2	1·10	nil	

P. —*Pectinophora gossypiella*.
E. —*Earias* sp. *fabia* and *insulana*.
H. —*Heliothis obsoleta*.
* Percentage of H. to E. and to P.

The usual plants attacked by *H. obsoleta* in South India are red gram (*Cajanus indicus*), Bengal gram (*Cicer arietinum*), groundnut (*Arachis hypogœa*), tomato, maize, cholam (*Andropogon Sorghum*), tobacco, *Cannabis sativa*, linseed, safflower, lablab (*Dolichos lablab*).—[E. BALLARD.]

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PLANT HYGIENE.

INCREASING INTEREST is being taken by farmers and commercial fruit and vegetable growers in science as applied to cultivation. Both old established societies—content in the past with their practical knowledge of crop cultivation—and newly formed societies—anxious to base their operations on scientific lines—are asking for lecturers who can demonstrate to them the advantages of the combination of theory and practice. The Ministry welcome such requests, and are endeavouring to meet them as far as possible.

In the middle of January a lecture was delivered in Norwich by Mr. G. C. Gough, B.Sc., an Inspector of the Ministry, on the subject, "Plant Hygiene in Relation to Crops." Mr. Gough first pointed out that *cleanliness* is as important to plants as to human beings, and gave instances of the large losses sustained in this and other countries from the depredations of the pests and diseases of plants and crops.

With regard to measures of control, the lecturer considered the subject under the four headings:—(1) Exclusion, (2) Protection, (3) Eradication, (4) Immunization. Under the first of these he dealt with the necessity of suitable crop rotation, whereby the succession on the same land of crops subject to the same pest was avoided; the advantages of reasonable separation when planting patches of such crops as bush fruit, in view of the possibility of epidemic outbreaks of disease; and the need for care in the purchase of seed, bushes or fruit-tree stocks to avoid the introduction of disease. Mr. Gough emphasized the large extent to which nurseries and seed firms are involved in this question, and in pointing out that the grower deserves every assistance to obtain clean and

good material, he foreshadowed the probability of legislation to deal with this aspect of the matter.

Under the heading of *protection*, the lecturer drew attention to the necessity of proper watering and ventilation for crops under glass, and the advantages of spraying and of soil sterilization as an insurance against the attacks of insects, fungi, etc.

It is difficult to draw a line between measures of protection and of eradication, and certain measures included by the lecturer under the latter heading apply equally to the former. Under whatever heading they are included, they constitute some of the most important precepts of plant hygiene, and the danger was emphasized (1) of permitting the rubbish heap to become the manure heap, and thus the breeding place of obnoxious plant pests, and (2) of feeding pigs and other animals on diseased food plants that had not been boiled. The lecturer pointed out that the passage of fungus spores unharmed, through the digestive system of animals, entailed their return to the land under conditions extremely favourable to the vigorous recurrence of disease.

Referring to the question of *pruning*, the lecturer urged its importance from the point of view of the removal of diseased wood, as well as from the purely cultural standpoint, and pointed out that to prune away diseased material without also burning it was but labour in vain. Mr. Gough also spoke at some length on the value of contact and poison insecticides and of the winter washing of fruit trees.

Of all matters relative to plant hygiene, the breeding of varieties immune from disease presents, perhaps, the largest field to the scientific investigator. The lecturer demonstrated by reference to those varieties of potato immune from wart disease that absolute immunity is an established fact; he pointed out the desirability of breeding varieties of crops immune from all the diseases to which they are at present liable, and also of combining this general immunity with good cropping and feeding qualities.

While it would be unwise to lose sight of the necessity of careful drainage, cultivation, manuring, etc., in the raising of healthy crops, attention to the measures outlined by Mr. Gough will be of

increasing benefit to the grower and to the nation.—[*Journal of the Ministry of Agriculture*, March 1920.]

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NEW SOURCE OF ALCOHOL.

Much attention has been given in recent years to the question of manufacturing alcohol within the Empire for use as motor spirit. In Vol. XVII, No. 3 (July–September 1919), of the Bulletin of the Imperial Institute, the possibility of utilizing the *mowra* (*Bassia latifolia*) flowers of India for the purpose is discussed. These flowers possess thick, juicy petals, rich in sugar. They are used by Indians as a foodstuff and especially for the preparation by fermentation of an alcoholic liquor called *daru* or *mohwa* spirit. A single tree will yield as much as 200–300 lb. of flowers in a year. The tree also produces a valuable oil-seed, which is exported in fairly large quantities to Europe. During the war the flowers were used in India for the production of acetone, the yield being said to be ten times as much as that obtained by distilling wood, which is the usual source of this substance. The demand for acetone in India in peace times, however, is not great, and large quantities of the flowers would be available for the manufacture of alcohol, and would appear to be an exceptionally cheap source of this material as the yield is high compared with that from potatoes and other materials commonly used, about 90 gallons of 95 per cent. alcohol being obtainable from one ton of dried flowers. It has been estimated that in the Hyderabad State alone there are already sufficient *mowra* trees for the production of 700,000 gallons of proof spirit per annum, in addition to that necessary for the local liquor requirements.

It is suggested that the most profitable way of utilizing the flowers would probably be as a source of mixed motor spirit of the "natalite" type for use in India. That motor spirit can be produced on a manufacturing scale in India from *mowra* flowers has already been demonstrated, and it is stated that running trials with the spirit proved satisfactory.

SUGAR FROM THE DOUGLAS FIR.

SURPASSING in strangeness any botanical discovery made in recent times is that of a new source of sugar in the leaves of the Douglas fir, which grows in certain confined portions of the dry belt of British Columbia. Professor John Davidson, F.L.S., F.B.S.E., of the University of British Columbia, spent much time in the dry belt region for the purpose of investigating the phenomenon. He found that trees on southern and eastern exposures on gentle slopes in the dry belt region of British Columbia lying between parallels 50 and 51, and longitude 121 to 122, chiefly yielded sugar. The trees which yielded were well apart, thus receiving a good supply of sunlight on their leaves, a more plentiful supply of sunlight on their roots, and having a better air circulation through them than trees in densely forested areas.—[*Production and Export*, April 1920.]

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

His Majesty the King-Emperor's Birthday Honours List contains the following names which will be of interest to the Agricultural Department:—

C.S.I. Mr. B. P. Standen, C.I.E., I.C.S., Commissioner, Central Provinces and Berar (sometime Director of Agriculture, Central Provinces and Berar).

C.I.E. Mr. C. M. Hutchinson, B.A., Imperial Agricultural Bacteriologist.

Mr. W. C. Renouf, I.C.S., Political Agent, Bahawalpur Agency, Punjab (sometime Director of Agriculture, Punjab).

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Dr. E. J. Butler, M.B., F.L.S., Imperial Mycologist and Joint Director of the Agricultural Research Institute, Pusa, has been appointed substantively *pro tempore* to be Agricultural Adviser to the Government of India and Director of the Agricultural Research Institute, Pusa, with effect from the 1st May, 1920.

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Mr. J. Mackenna, M.A., C.I.E., I.C.S., on leaving Simla to take up his appointment as Development Commissioner in Burma, resigned his appointment as President of the Indian Sugar Committee, with effect from the 26th April, 1920. Mr. F. Noyce, I.C.S., has been appointed to the Presidency of the Committee with effect from the same date.

MR. W. SMITH, Assistant Director of Dairy Farms, Southern Circle, whose services have been placed at the disposal of the Department of Revenue and Agriculture, with effect from the 1st May, 1920, is appointed Imperial Dairy Expert, with effect from the same date, in the Imperial Department of Agriculture in India.

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MR. G. P. HECTOR, M.A., B.Sc., Officiating Imperial Economic Botanist, has been placed, with effect from the 1st May, 1920, in charge of the current duties of the Imperial Mycologist, in addition to his own.

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MR. W. WYNNE SAYER, B.A., has been appointed Supernumerary Agriculturist, with effect from the 20th January, 1919.

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DR. J. N. SEN, M.A., F.C.S., Supernumerary Agricultural Chemist, has been appointed, with effect from the afternoon of the 10th April, 1920, to act as Imperial Agricultural Chemist during the absence of Dr. W. H. Harrison on leave.

***

MR. N. V. JOSHI, B.A., M.Sc., L.Ag., First Assistant to the Imperial Agricultural Bacteriologist, has been appointed, with effect from the 11th April, 1920, to act as Assistant Agricultural Bacteriologist, *vice* Mr. J. H. Walton, B.A., appointed to officiate as Imperial Agricultural Bacteriologist.

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MR. A. L. SHEATHER, B.Sc., M.R.C.V.S., Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar, has been granted privilege leave for three months and 24 days from the 17th April, 1920.

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MR. W. A. POOL, M.R.C.V.S., Offg. Second Bacteriologist, has been placed in charge of the current duties of the Director and First Bacteriologist, in addition to his own, during the absence on leave of Mr. A. L. Sheather, with effect from the 17th April, 1920.

Mr. A. C. Dobbs has been appointed to be substantively *pro tempore* Director of Agriculture, Bihar & Orissa, with effect from the 6th January, 1920.

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The services of Mr. G. Clarke, F.I.C., Agricultural Chemist to Government, United Provinces, and Officiating Principal of the Agricultural College, Cawnpore, are placed at the disposal of the Government of India, Department of Revenue and Agriculture, with effect from the date he may be relieved of his present duties.

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Mr. P. K. Dey, who has been appointed by His Majesty's Secretary of State for India to the Indian Agricultural Service, has been appointed to be Plant Pathologist to Government, United Provinces, with effect from the 1st March, 1920.

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Mr. C. H. Parr, who has been appointed by His Majesty's Secretary of State for India to the Indian Agricultural Service, has been appointed to be Deputy Director of Agriculture and to be in charge of cattle-breeding, United Provinces, with effect from the 31st December, 1919.

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On the completion of his training at Lyallpur, Malik Sultan Ali has been posted as Deputy Director of Agriculture, 1st Circle, Gurdaspur, with effect from the 6th April, 1920.

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Mr. T. F. Quirke, M.R.C.V.S., Officer on special duty in the office of the Chief Superintendent, Civil Veterinary Department, Punjab, took charge of the duties of Officiating Chief Superintendent, Civil Veterinary Department, Punjab, with effect from the afternoon of the 22nd March, 1920, relieving Colonel J. Farmer, C.I.E., F.R.C.V.S., who proceeded on combined leave.

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Captain K. J. S. Dowland, M.R.C.V.S., Professor of Sanitary Science, Punjab Veterinary College, Lahore, assumed

charge of the duties of the Professor of Surgery, in addition to his own, on the afternoon of the 31st March, 1920, from which date Mr. E. Burke, Professor of Surgery, retired from Government service.

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Mr. T. M. Doyle, M.R.C.V.S., has been appointed to the Indian Civil Veterinary Department, with effect from the 21st March, 1920, and is posted to the Government Cattle Farm, Hissar, Punjab.

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Mr. G. McElligott, M.R.C.V.S., has been appointed to the Indian Civil Veterinary Department, with effect from the 27th May, 1920, and is posted to Madras as Second Superintendent, Civil Veterinary Department in that Presidency.

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Mr. G. F. Keatinge, C.I.E., I.C.S., on return from leave, has been appointed Director of Agriculture and of Co-operative Societies, Bombay, *vice* Dr. Harold H. Mann placed on special duty in the same office till the date of his departure on leave.

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Dr. H. H. Mann is granted, with effect from the date of relief, combined leave for eight months.

***

Mr. T. F. Main, B.Sc., Deputy Director of Agriculture, Sind, has been allowed, by His Majesty's Secretary of State for India, an extension of furlough for six months.

***

Mr. T. Gilbert, B.A., Deputy Director of Agriculture, Southern Division, Bombay Presidency, has been allowed, with effect from the 1st May, 1920, the amount of privilege leave due to him combined with three months' leave on urgent private affairs.

Rao Saheb M. L. Kulkarni has been appointed to act as Deputy Director of Agriculture, Southern Division, Bombay Presidency, during the absence on leave of Mr. T. Gilbert, pending further orders.

***

Mr. P. C. Patil, L.Ag., Deputy Director of Agriculture, Central Division, Bombay Presidency, has been allowed an extension by two weeks of the privilege leave granted to him.

***

Mr. K. Hewlett, O.B.E., M.R.C.V.S., has been allowed by His Majesty's Secretary of State for India an extension of commuted furlough for four months.

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On return from leave, Mr. G. Evans, M.A., C.I.E., Deputy Director of Agriculture, Central Provinces, is posted to the Northern Circle.

***

Mr. C. P. Maya Das, M.A., B.Sc., Assistant Director of Agriculture, Central Provinces, is confirmed in his appointment, with effect from the 18th May, 1920, but will continue to officiate as Deputy Director of Agriculture, Western Circle, Central Provinces.

***

Mr. R. F. Stirling, who has been appointed by His Majesty's Secretary of State for India to the Indian Civil Veterinary Department and posted to the Central Provinces, assumed charge as Second Superintendent, Civil Veterinary Department, Central Provinces, on the 8th April, 1920.

***

Mr. A. McKerral, M.A., B.Sc., Deputy Director of Agriculture, Burma, has been granted privilege leave for six months, with effect from the 1st June, 1920, or the subsequent date on which he may avail himself of it.

Col. G. H. Evans, C.I.E., C.B.E., M.R.C.V.S., Superintendent, Civil Veterinary Department, Burma, made over and Mr. T. Rennie, M.R.C.V.S., received charge of the duties of Second Superintendent, Civil Veterinary Department, Burma, on the 15th April, 1920. He also made over charge of the office of Third Superintendent to Mr. C. J. N. Cameron on 17th May, 1920.

Reviews

Notes on Improved Methods of Cane Cultivation.—By G. CLARKE, F.I.C., NAIB HUSSAIN and S. C. BANERJEE, Department of Land Records and Agriculture, United Provinces; 1919, pp. 23+10 plates. (Allahabad: Government Press.)

THIS little volume records the results obtained at the Sugarcane Research Station, Shahjahanpur, where a large number of canes have been under trial for several years. The possibilities of intensive cultivation of improved sugarcane, selected to suit local conditions, have been dealt with at some length, and can easily be measured by the average yield of about 100 maunds of *gur* per acre obtained at the station over a number of years, as against 32·6 maunds, the average yield in the United Provinces in 1916-17, from *deshi* canes by the ordinary methods of cultivation. Besides better preparation of the land and the adoption of suitable methods of moisture conservation and soil aeration, the authors advocate the sowing of sugarcane in trenches 2 feet wide and 4 feet from centre to centre as the most suitable for thick and medium canes both as regards germination and yield per acre. To obtain a good crop by these methods of cultivation, manure containing 120 to 150 lb. of nitrogen (equivalent to about 35 to 40 maunds of castor cake) is however required. This is the heaviest item of expenditure involved, but it is definitely stated that a handsome return has always been obtained. The effect of liberally manuring the cane is not confined to that crop alone: the residual nitrogen and the deep cultivation of the trenches effect a striking increase in the yield of wheat or other crops followed by sugarcane, and, to cite an instance, in the harvest of the 1919 *rabi* crop, 36½ maunds per acre of Pusa 12 wheat were obtained over a

field of 3½ acres, with one irrigation only. The preceding crop was Mauritius sugarcane, which yielded 948 maunds per acre or nearly three times the ordinary yield of indigenous varieties.

The intensive methods of cultivation have not, however, been so profitable with the *deshi* canes. Trials have shown that "heavy manuring with nitrogenous manure generally gives rise with *deshi* varieties to excessive vegetative growth without a proportionate formation of sucrose or crystalline cane sugar and, moreover, delays the ripening beyond the time when crushing operations are possible." The potentialities of even the best *deshi* canes in this part of the United Provinces appear to be very limited, but with deeper ploughing, application of small quantities of manure and growing pure races, the outturn can be appreciably increased.

The advantages of using small power mills, in places where central factories do not exist, are also clearly dealt with, and the rotation of crops followed at the Research Station is explained.

There can be no two opinions of the vital interest and importance of the problem of increasing the yield of sugarcane at the present time when the prices of both raw and refined sugar are ruling so high. The world's demand for sugar is continuously increasing, while its production by extension of area is not showing prospects of equal increase. The best solutions of the vexed problem of meeting the increasing demand for it seem, therefore, to lie in increasing the yield per acre by better varieties and intensive methods of cultivation, conducted with scientific skill and care, and by improved processes of manufacture. The United Provinces command about half the total area under sugarcane in British India, and there is a wide scope for introducing the improvements recommended by the authors of this volume, especially as it may now be safely assumed that at no time in the near future is the supply of *gur* or sugar likely to overtake the demand and that high prices are bound to prevail for many years to come, with a correspondingly good margin of profit to the cultivator. The successful adoption of the methods, with regard to improved canes, is, however, dependent on irrigational facilities, capital and intelligent supervision,

and will probably prove beyond the means of the ordinary cultivator; but we hope that the wealthier cultivators and zemindars of the provinces will seriously consider the possibilities and will take the lead in bringing about these improvements which will also ultimately raise the standard of agricultural practice of the country. [EDITOR.]

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Agricultural Statistics of India, 1917-18, VOL. I. Pp. 321+2 maps+9 charts. (Calcutta: Superintendent, Govt. Printing, India.) Price Rs. 2.

THIS annual volume is the thirty-fourth of the series started in 1886 with statistics for 1884-85, and has just been issued by the Department of Statistics, India. It deals with the figures relating to British India only, and, like its preceding issues, is a source of varieties of useful information for all who take an interest in agricultural questions. Statistics are usually stale; nevertheless, a study of this volume will be profitable to many.

The actual area dealt with in this volume is 617,507,000 acres. After allowing for forests, buildings, water, roads, etc., we find that a balance of 387,799,000 acres or 63 per cent. remained available for cultivation, but the net area actually cropped during the year was 227,848,000 acres or 37 per cent. of the total area as against 229,620,000 acres in the preceding year, a decrease of 0·8 per cent. If areas cropped more than once are taken as separate areas for each crop, the gross area cropped in the year amounts to 264,817,000 acres. The area under food grains showed a decrease of 1,336,000 and that under oil-seeds of 527,000 acres as compared with the preceding year. There was an increase of 386,000 acres under sugarcane and of 1,566,000 acres under cotton, attributed chiefly to the stimulus of high prices obtained in the preceding year.

While it is admitted that the Indian figures of area are hard to beat in the matter of accuracy, the same, unfortunately, cannot be said of the figures of average and total yields. The importance of accurate agricultural statistics is, however, fully realized by the Departments of Agriculture and Statistics, and the whole question

received careful consideration of the Board of Agriculture in India held in December 1919, at which the Department of Statistics was represented by its Director. Efforts are being made to arrive at more reliable figures of yields and it may be reasonably expected that, as time goes on, they will become more and more accurate. [EDITOR.]

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS

1. A Student's Book on Soils and Manures, by Dr. E. J. Russell. Second Edition, revised and enlarged. (The Cambridge Farm Institute Series.) Pp. xii+240. (Cambridge: At the University Press.) Price 6*s*. 6*d*. net.

2. The Fauna of British India, including Ceylon and Burma. Coleoptera. Chrysomelidæ (Hispinæ and Cassidinæ), by Prof. S. Maulik. Pp. xi+439. (London: Taylor and Francis.) Price 1 guinea.

3. Chemical Fertilizers, by S. Hoare Collins. Pp. xii+273. (London: Baillière, Tindall and Cox.) Price 10*s*. 6*d*.

4. Productive Sheep Husbandry, by W. C. Coffey. Pp. x+479. (Philadelphia and London: J. B. Lippincott Company.) Price 10*s*. 6*d*. net; post free, United Kingdom and abroad, 11*s*. 3*d*.

5. Botany for Agricultural Students, by John C. Martin. Pp. x+585. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd.) Price 12*s*. 6*d*. net; post free, United Kingdom, 13*s*.; abroad 13*s*. 6*d*.

6. Mining and Manufacture of Fertilizing Materials and their Relation to Soils, by Strauss L. Lloyd. Pp. vi+153. (New York: D. van Nostrand Company; London: Crosby, Lockwood & Son.) Price 9*s*. net; post free, United Kingdom and abroad, 9*s*. 4*d*.

7. Fossil Plants: A Text-book for Students of Botany and Geology, by Prof. A. C. Seward, Vol. IV: Ginkgoales, Coniferales,

Gnetales. (Cambridge Biological Series.) Pp. xiv+543. (Cambridge: At the University Press.) Price 1 guinea net.

8. Bacteriology and Mycology of Foods, by Dr. Fred Wilbur Tanner. Pp. vi+592+10 plates. (New York: John Wiley & Sons, Inc.; London: Chapman and Hall, Ltd.) Price 28*s.* net.

9. Food: Its Composition and Preparation. A Text-book for Classes in Household Science, by Mary T. Dowd and Jean D. Jameson. (The Wiley Technical Series.) Pp. viii+173. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) Price 6*s.* net.

10. Chemistry and its Mysteries: The Story of What Things are Made of. Told in Simple Language, by Charles R. Gibson. (Science for Children.) Pp. 216. (London: Seeley, Service Co., Ltd.) Price 4*s.* 6*d.* net.

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